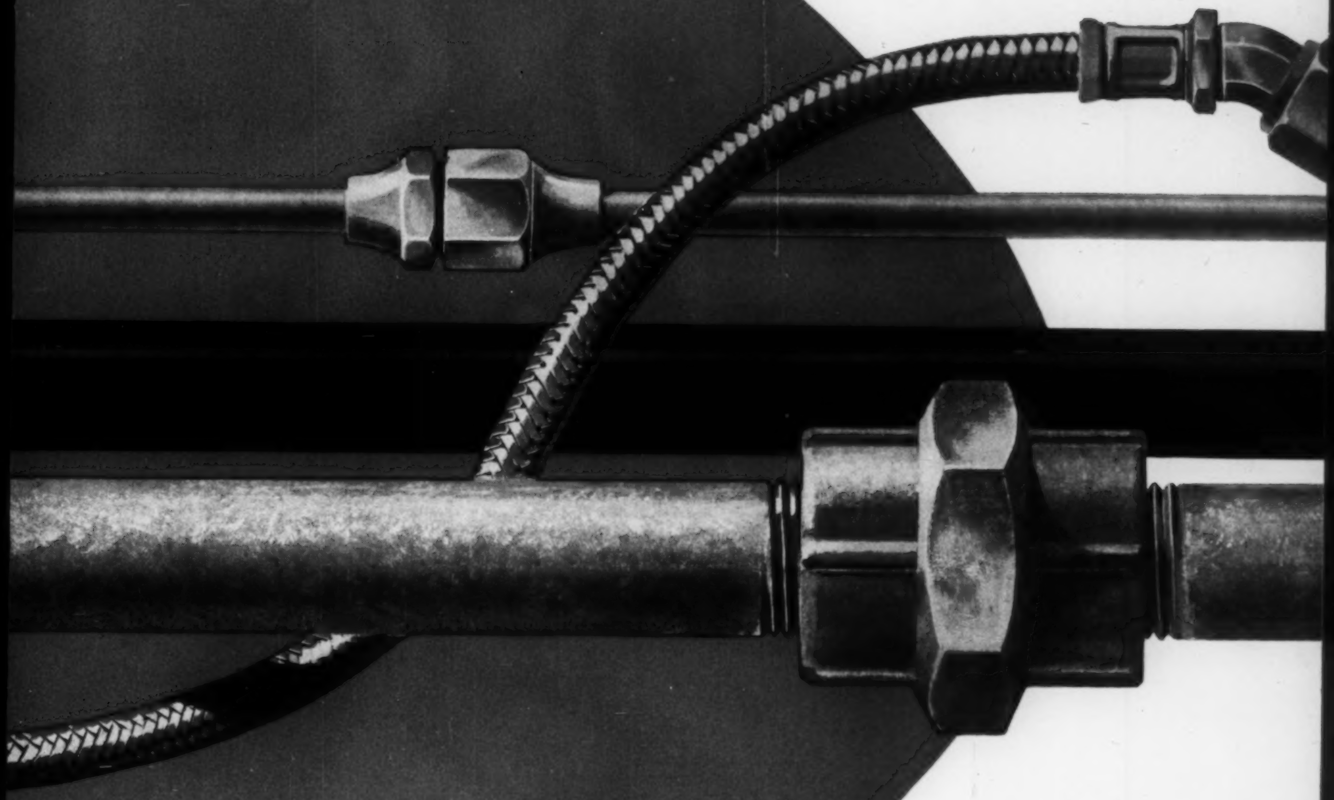
APRIL 16, 1959

MACHINE DESIGN

A PENTON PUBLICATION — BIWEEKLY


FARNSWORTH

Hydraulic Lines

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POROUS

SELF-LUBRICATING

SINTERINGS

BEARINGS

POWDERED METAL BEARINGS

BEARINGS

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BEARINGS

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METAL POWDER

BEARINGS

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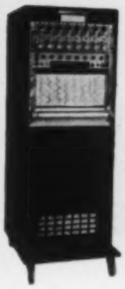
HERE'S WHY.. | *Leading instrument manufacturers power their products with Bodine Motors*

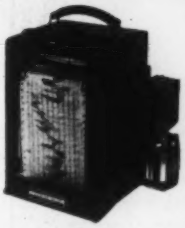
LEEDS & NORTHRUP SPEEDOMAX® H INSTRUMENTS

"Our Speedomax H line includes indicators, recorders, and controllers, which measure or control temperature, pH, gas concentration, power and load, and neutron density in many industrial, power plant, and research applications. These instruments are designed for 24-hour operation, seven days a week. All components must be rugged, dependable. Many of the instruments in the Speedomax H line are powered with Bodine Motors."—Leeds & Northrup Company.



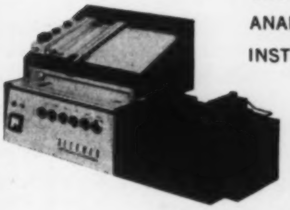
SANBORN OSCILLOGRAPHIC RECORDING INSTRUMENTS

"Time is very important in recording electrical and physical properties . . . and this is one reason we use Bodine synchronous motors. These instruments can operate at nine different paper chart speeds. The motor that powers the chart moving mechanism must respond quickly . . . operate at any of the pre-determined constant speeds. Over the years Bodine Motors have met our requirements for constant speed, minimum noise, uniform performance, and long life."—Sanborn Company.



ESTERLINE-ANGUS RECORDERS

"We needed a motor that would run quietly, start fast, and accurately maintain the required speed. Also, it was necessary that both AC and DC motors have the same mounting dimensions. We wanted a source where delivery promises would be kept, and also where motor parts would be quickly available. Bodine met all these requirements, plus making our external drives less cumbersome."—The Esterline-Angus Company, Inc.



BECKMAN ANALYTICAL INSTRUMENTS

"Bodine motors are used in several of our precision instruments where critical specifications must be met and maintained. In addition, twenty-four hour operation is common place in the use of our products for important research."—Beckman Scientific and Process Instruments Division.

Free—ask for descriptive bulletins 1023B and 1024A

Bodine K-2 Motors were designed to power instruments

Many manufacturers of instruments, timing devices, control apparatus, and similar products use Bodine K-2 Motors. K-2's are small, compact motors . . . only 2⅜" high . . . perfect for those hard-to-get-at installations. Instantly reversible and totally enclosed, they're available synchronous or non-synchronous . . . with or without speed reducers. Horsepower range: 1/2000 to 1/500. Bodine Electric Co., 2508 West Bradley Place, Chicago 18.

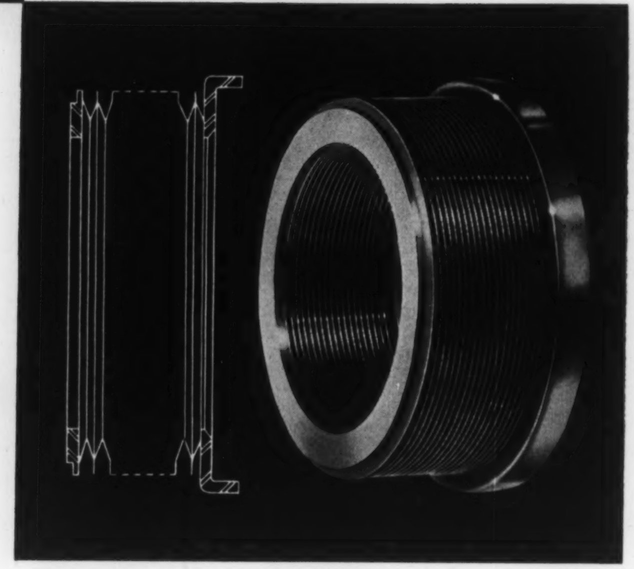
BODINE
fractional horsepower
MOTORS

Other applications for Bodine Motors: vending machines, communication equipment, sound recorders, automatic scales, respirators, voltage regulators, X-ray timers, traffic signal timers, stirrers, sanders, letter openers, envelope sealers . . . plus many, many other applications.

. . . the power behind the leading products

DESIGN NOTES

How C/R's New Metal Bellows Seal Meets Seemingly Impossible Operating Conditions



Operating Ranges

Temperature	−400° to 1000° F.
Pressure	500 psi
R.P.M.	80,000 plus

These known operating ranges indicate the function of this seal. It is designed for applications where temperatures and mediums to be sealed forbid the use of any organic materials. Typically, these applications include fuel pumps, compressor power units and turbine starters characteristic in rockets and missiles. Other applications include mechanisms which are exposed to a high level of radioactivity.

Design Advantages

The C/R metal bellows seal consists of a metal bellows — a welded homogeneous unit which is secured at one end — and a carrier ring in which the sealing face is mounted. The seal does not contact the shaft. It is stationary, and the only rubbing surfaces are the sealing face and mating ring. These surfaces are precision lapped to provide a positive seal with minimum friction. At any given pressure, the seal can be designed to maintain proper and constantly effective face loads. It orients immediately to run-out and will resist any torques it is subjected to in operation. The design has high end-play tolerance: Chicago Rawhide engineers have deflected a bellows .100 in. for three million cycles at 1750 cpm and at a temperature of 500° F. with no adverse effects.

A further advantage is relatively light weight and compactness. The C/R metal bellows seal can be designed for minimum axial and radial space. Axially, complete seals can be produced within a ¼ in. cross-section. Radially, dimensions are comparable with conventional end face seals.

The C/R metal bellows seal can also be designed with an extremely low coefficient of expansion. The importance of this factor becomes apparent with the fact that in many applications the operating temperature may change hundreds of degrees in a very few seconds.

Mediums To Be Sealed

Virtually any known liquid or gas may be positively sealed with this design, depending upon duration or service life. From a practical viewpoint, the C/R metal bellows seal is the best design for the sealing of cryogenic and high-energy fuels such as LOX, hydrogen peroxide, fluorine and other missile and rocket propellants.

Where possible, lubrication of the two sealing faces is desirable to prolong service life. However, the medium being sealed commonly acts as the lubricant and may be merely hot gas.

Materials

Sealing faces and mating rings for the C/R metal bellows seal are available in a variety of materials including carbons, carbides, ceramics and various alloyed metals for both high temperature and corrosion resistance. The bellows can be furnished in any of several metals and alloys such as stainless steel, Monel, Inconel X, Ni-Span C and other special alloy steels.

Consult C/R Engineers

Each application for the C/R metal bellows seal is essentially a custom-design and an intimate knowledge of all conditions to be encountered must be known by Chicago Rawhide engineers to produce the correct combination of properties in the seal. Then, whether you require five, fifty or five thousand seals, Chicago Rawhide will design and produce the correct seal to solve your problem.

Helpful Design Data:

We will gladly furnish you with a design guide and space envelope data concerning the C/R Metal Bellows Seal. Just write for Bulletin MBS-1 on your company letterhead.

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MANUFACTURING COMPANY
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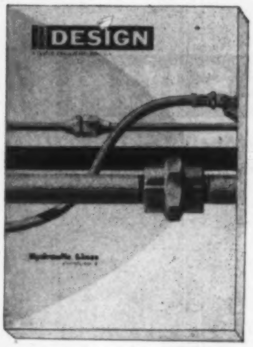

Front Cover: A pipe, a tube, or a flexible hose—that's what hydraulic lines are made of. But the engineering problem's not as simple as George Farnsworth's cover design might indicate; J. J. Taborek's series starting on Page 158 points out some of the problems and supplies a wealth of practical answers.

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New Army-sponsored study aims at "nondimensional" wheel-design parameters for off-highway vehicles—water-cooled copper pressure plates beat the heat in new clutch-brake line—Ford says fuel economy of its automotive gas turbine rivals diesel, beats gasoline engines—"lenticular" display stores, projects 20 messages without lenses—off-the-shelf components make obsolete weapons says Polaris designer.

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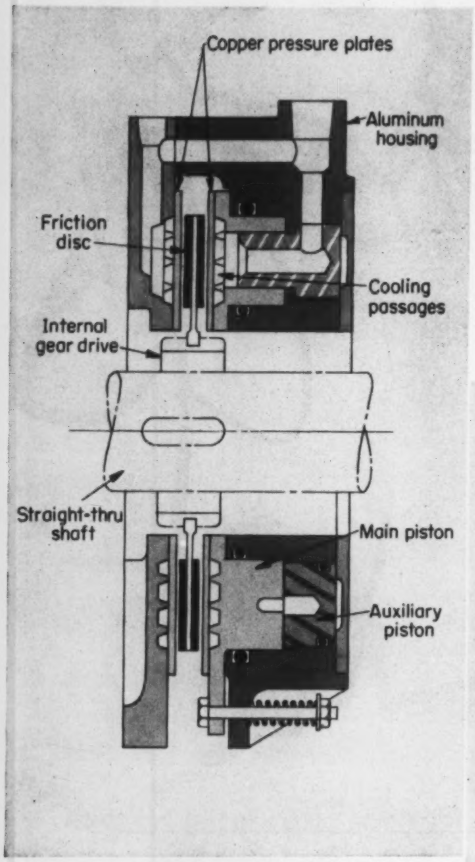
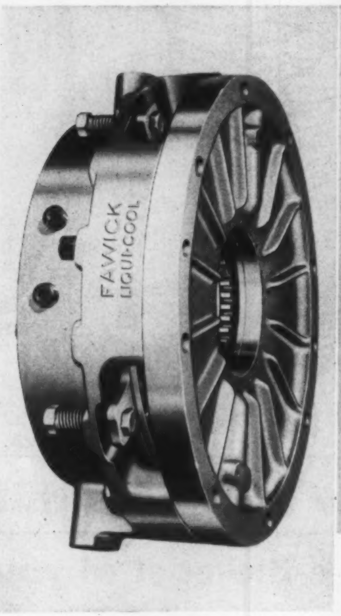
ENGINEERING NEWS

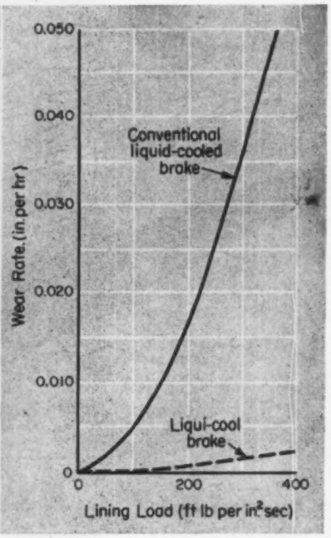
Copper Clutch Discs Beat the Heat

Fast heat removal from friction surfaces is the key to exceptional performance in a new family of water-cooled brakes and clutches. Developed by Fawick Corp.'s Airflex Div., Cleveland, the new units use copper pressure plates instead of cast iron (copper's thermal conductivity is better by a factor of 8). Since the plates have spiral-grooved backs in direct contact with the water coolant, a remarkable rate of heat dissipation is obtained. This permits increased energy absorption per sq in. of lining and gives more torque capacity in a given size brake. The brakes and clutches are particularly suitable for high-inertia jobs—where large WR² loads are started and stopped—or in constant-tension braking or continuous-slip clutching. A new friction material, compatible with copper, was developed especially for the new units by Raybestos-Manhattan Inc., Bridgeport, Conn.



Multiple-piston design adds versatility to Liqui-cool brakes and clutches. Operation with the main annular-ring piston provides full torque range; operation with auxiliaries gives ¼-torque range for off-design load conditions.





Wear rate is drastically reduced by effective cooling in the new Liqui-cool brakes and clutches.

Off-the-Road Wheels Are Subject of New Research

Army-Sponsored Program Will Size Wheels for Any Soil

ANN ARBOR, MICH.—Since its invention some 6000 years ago, the wheel has rolled over progressively harder and smoother surfaces. Millions of dollars have been spent in finding the most suitable rubber and synthetic for automobile tires, and in perfecting superhighway design and construction. And until now, no basic research has sought to get the best performance from a wheel on a vehicle moving over natural (unpaved) terrain.

Today, for example, how would an engineer determine the diameter, width, and surface shape of wheels designed for swampy or very soft ground? How would he determine the best wheel configuration for rocky, bumpy surfaces?

Research at the University of Michigan's Automotive Laboratory, aimed at correcting this situation, is producing for the first time scientific data applicable to off-the-road wheel behavior, including how soils react to wheels and wheel pressures.

According to U-M Scientists, the ultimate goal is to correlate results on a dimensionless basis. This amounts to working out a mathe-

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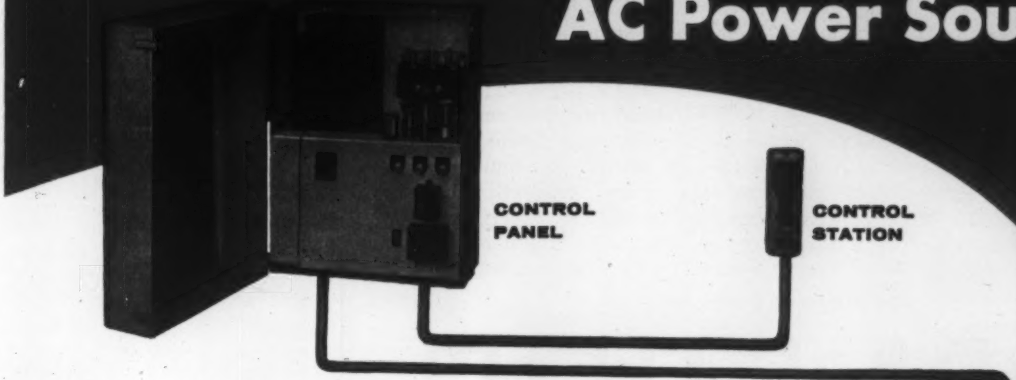

The complete Dynamatic power package includes all components required to provide infinitely adjustable speeds from an alternating current power source. A Dynamatic Ajusto-Spede® or Dynaspede® Drive, with electronic control and pushbutton station, satisfies the requirements of almost any application where proper machine operation or material processing depends upon control of operating speeds.

The compact control panel may be remotely mounted to conserve valuable space on the driven machine. The pushbutton station at the operator's position puts vital controls conveniently at the operator's fingertips and requires a minimum of space.

Speeds are infinitely adjustable from 0 RPM to full output speed, and accurate speed regulation may be obtained from 100 RPM to full output speed.

Ajusto-Spede® Drives, available in ratings of 1/4 horsepower to 75 horsepower, are air-cooled. Dynaspede® Drives, rated from 3 to 75 horsepower, are liquid-cooled. Raise your productive efficiency with Dynamatic eddy-current units.

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matical method of determining in advance how a wheel of any diameter and width will respond at any given speed and load under off-the-road conditions. This includes a determination of soil parameters (stresses and compressibility of various soils) and how these factors respond to changing weather conditions and to various loads and wheels.

"This is a long range program," states Edward T. Vincent, professor of mechanical engineering, who heads the project. It is being conducted for the Army Ordnance Corps' Detroit Arsenal through the University's Research Institute.

"The first major step in the project, now in its third year, was to perfect test the apparatus to get reproducible results. Model wheels of various diameters and widths are towed through a 40-ft long trough filled with sand or artificial soils.

At first, says Vincent, the sand would pack down after being run over once or twice with a scale wheel, but it is now reconditioned by shaking it up with compressed air at the bottom of the trough.

"We also have designed and proved a method to get the point force of earth on a wheel. We have determined that the soil exerts force on a wheel roughly from in front of the wheel at the level of the earth, to behind the wheel and just above the level to which the weight of the wheel has compressed the earth.

"This means that mathematically it should soon prove possible to calculate in advance of actual tests just how much force will be exerted on a vehicle's wheels, which in turn can indicate the horsepower needed under certain conditions."

12345678

Bad Day for Bad Checks

Ten times faster than manual sorting by one person, Burroughs magnetic character sorter holds the world's speed record of 1500 bank checks per minute. The unit reads special numbers and characters, shown above, preprinted on checks by a companion unit. A completely automated banking system is now possible based on the preprinted character principle. Because the average check is handled by many people before being deposited, the device has been designed with a high tolerance for processing worn documents. Paper or card checks of varying sizes and thicknesses, as well as those having been mutilated, may all be processed simultaneously. Bad days for bad checks are prophesied.

Topics

Roll out the barrel—and fly it. This unlikely phenomenon occurs when the *coleopter*, a barrel-shaped aircraft, is flown. Coleopter, a word of Greek derivation, means sheath-winged. The sheath of the aircraft, a distant relative of the helicopter, is the barrel-shaped outer structure. The coleopter takes off vertically, then changes to a horizontal position for forward flight. Lift is provided by airflow over the circular "wing," and a propeller inside the sheath or a jet engine supplies power. Advantages of coleopter design are structural strength, provided by the symmetrical exterior; high thrust per horsepower, resulting from a propeller operating in a confined space; and vertical take-off.

• • •

A stenographer's best friend could be a typewriter that automatically transcribes her notes. A working model of such a machine accepts tape containing notes made on a stenographic machine, translates the symbols into English, and stores the letters. Finally, the machine operates typewriter keys to produce a typed version of the original notes.

• • •

Data on the data processors is kept by a Bar Chart Recorder, developed by Gorrell & Gorrell, Westwood, N. J. Performance checks are made on each of a group of computers, at two-minute intervals. If the subject machine is operating properly, a constant line will show on its performance chart. Results of the checking indicate length of time required to set up a machine, steadiness of the work flow, and downtime due to absence of the operator.

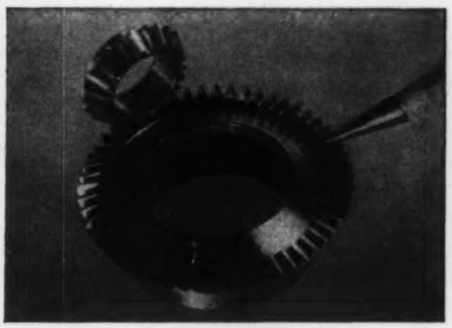
• • •

Really "automatic" saving will be possible at a Chicago bank which is instituting a department-store type charge plate system to speed handling of deposits.

• • •

Astronomical interest, precipitated by the space age, will triple or quadruple the number of U. S. astronomers in the next ten years, according to Prof. Leo Goldberg, head of the University of Michigan's Astronomy Dept. He says that many of these people will come into the field by the "conventional routes," but many more will be "attracted from the neighboring fields of physics, mathematics, and engineering." Astronomers in this country now number 800; they and more like them are needed for such duties as calculating trajectories for space vehicles, supplying information on conditions on other planets, and giving advice on instruments to be sent into space.

CURVIC COUPLINGS provide an accurate, light, compact, and self-contained connection in which the teeth both center and drive. The Curvic design represents a new standard in the application of coupled parts.



BEVEL GEARS

When a gear or a coupling determines the *accuracy of trajectory*...

When a missile or rocket works on paper the best way to get it into the air is to see to it that all the parts agree with the paper work.

And when one of those parts is a bevel gear or coupling, Gleason engineers can help you three ways:

1. Engineering service. Our full staff of engineers is ready at all times to help you develop bevel gear combinations and Curvic® Coupling designs. They can help you make sure that either part meets your specifications.

2. Machines to cut or grind to your tolerances. You can produce any fine pitch gear—spiral bevel, hypoid, Zerol® or Coniflex®—precisely and economically with any of five Gleason machines.

No matter how rigid your specifications or the size of your parts, our engineers can help you select the right machine or combination of machines for 100% accuracy.

3. Complete testing equipment. We have engineered a series of testers for making certain that all parts do meet your critical specifications. For example, on the Gleason No. 104 Hypoid Tester you obtain a permanent test record to help you match pairs properly and to keep a graphic record of the rolling qualities, tooth spacing, and concentricity of your parts.

Any or all of these services are yours for the asking at any time.

GLEASON WORKS

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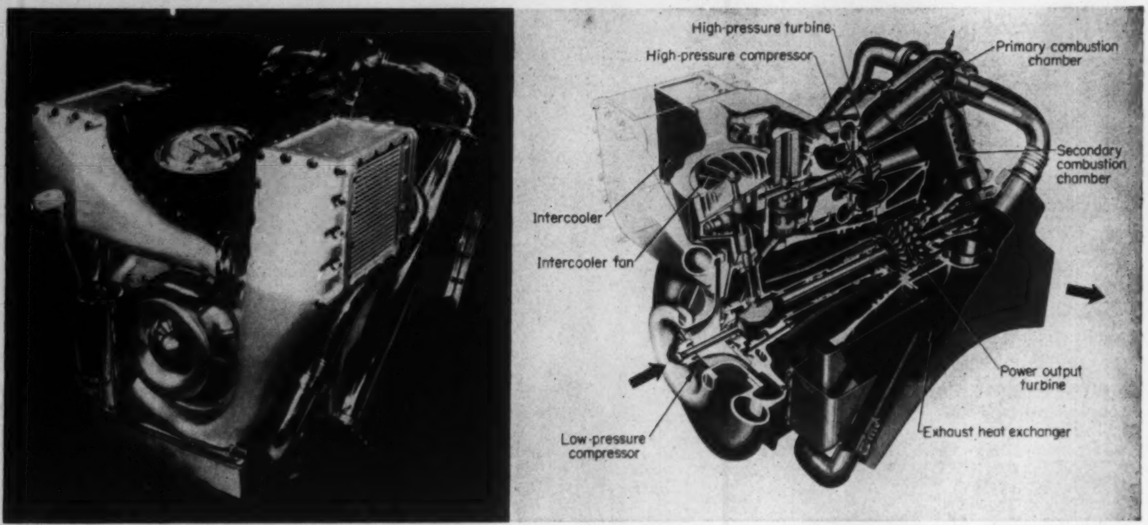
Supercharged Gas Turbine Starts Road Tests at Ford



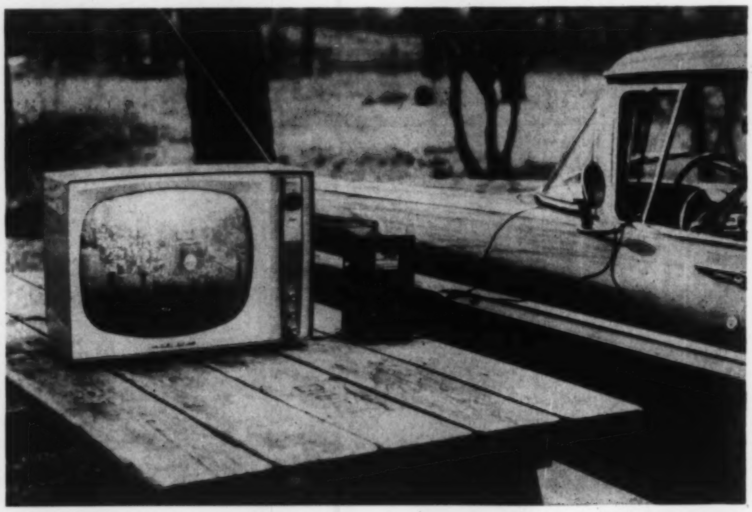
First automotive turbine with two-stage compression, Ford's new engine attains maximum fuel economy in the range of 25 to 100 per cent of power. Ready for testing now in cars, trucks, tanks, and a wide range of other vehicles, the unique supercharged powerplant is rated at 300 hp. It weighs 650 lb installed, vs. 2700 lb for a comparable horsepower diesel truck engine. Fuel economy of the turbine rivals a diesel and is superior to gasoline engines in most applications. Each compressor stage effects a 4:1 compression ratio. The low-speed compressor turns at 46,500 rpm; the high-speed compressor at 91,500 rpm. Both primary and reheat combustion chambers operate at 1700 F. Exhaust gases are discharged at about 740 F, or roughly the same temperature as passenger-car engine exhaust. Package size of the 704: 38 in. long, 29 in. wide, 28 in. high. Specific fuel consumption is 0.56 lb per bhp per hour at full power, 0.48 at ½ power, and 0.58 at ¼ power.

Portals to Space Flight Opened for Seven Pioneers

WASHINGTON—Seven selectees have been appointed for orbital flight training by the National Aeronautics and Space Administration. While five less than originally anticipated, the smaller number will assure each more complete participation in all phases of the project.

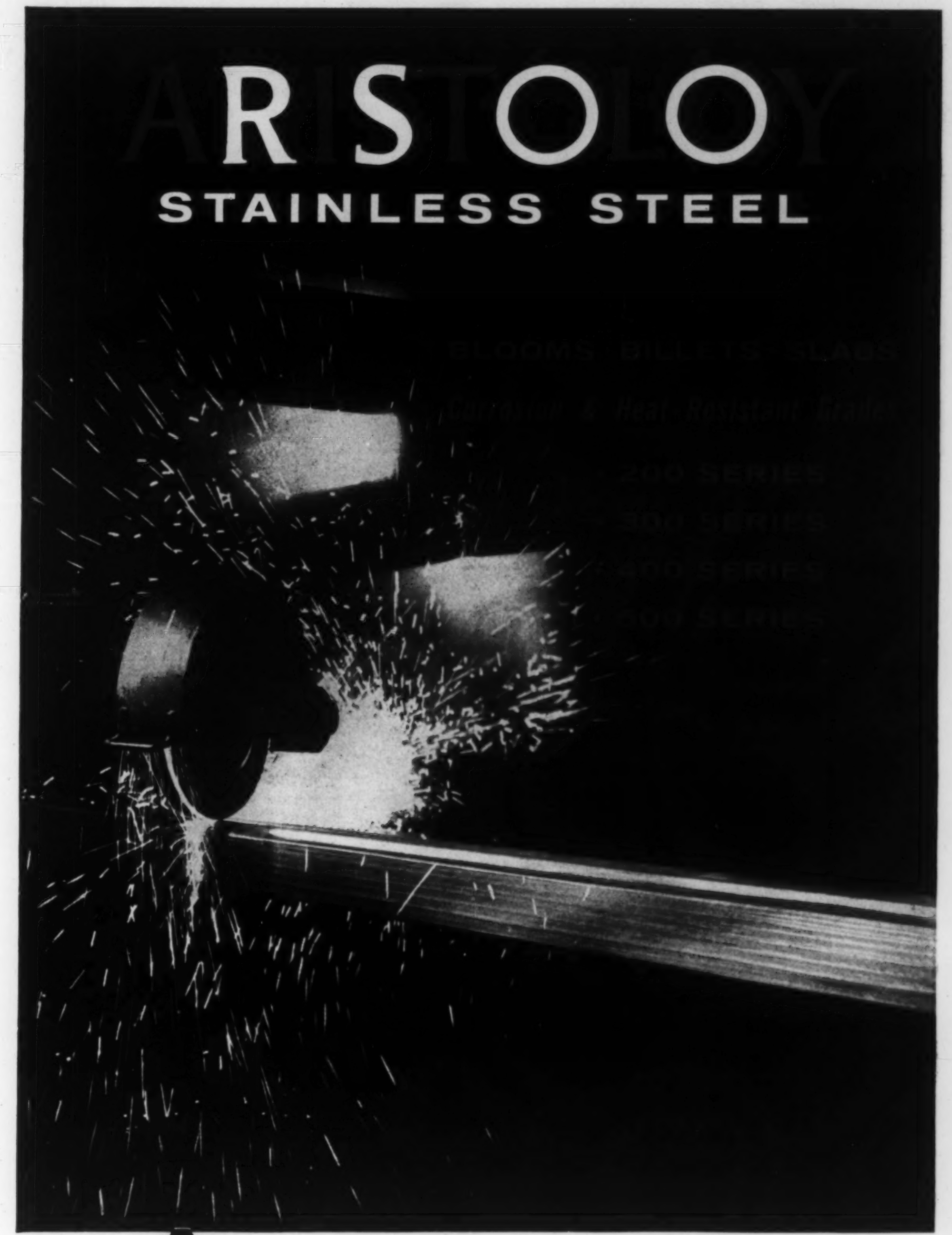
All members of the group of 32 originally picked were of such high caliber that selection was difficult. Each had obtained either an engineering or a physical science degree and had graduated from a military test pilot school. Each had more than 1500 hr flying time and had satisfied rigid physical, emotional, and stress tolerance standards.

The astronauts proceeding further in the program will have important roles in both engineering and scientific development of a space vehicle. Suborbital buildup missions and manned satellite flight are both on their schedules for the not-too-distant future.



TV Picnics?

First solid-state inverter intended for consumer use promises to revolutionize outdoorsmanship. The living room can now come along on the picnic. Originally designed for only military applications, the inverter converts 6 or 12-v dc to 115-v 60-cycle ac current by transistor circuits and magnetic components. According to Magnetic Amplifiers Inc., New York, it may be used with any household electric appliance drawing less than 200 w. Plugged into the cigarette lighter receptacle of the dashboard, it can be used whether or not the automobile engine is running. The inverter should be especially attractive to the audiophile hampered by room wall and ceiling limitations to stereo enjoyment.



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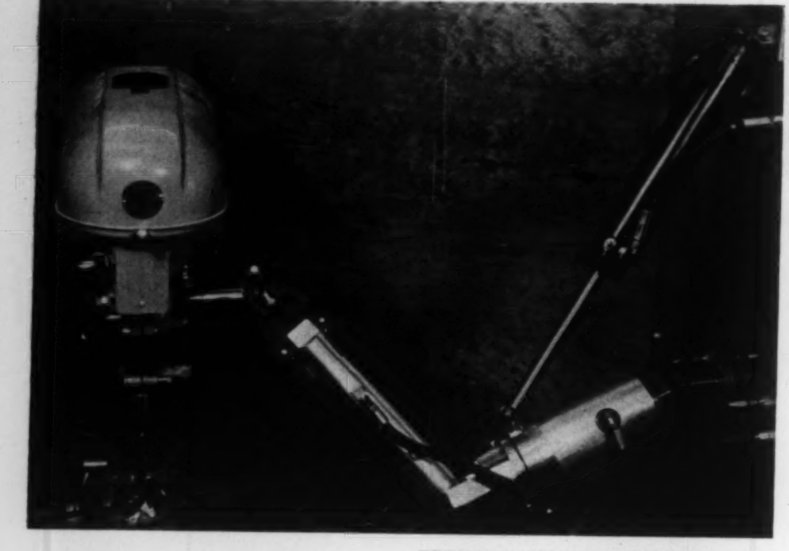
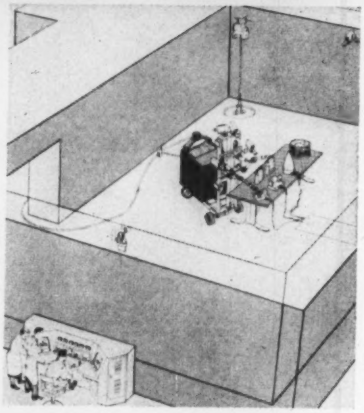


Personnel for the Hot Lab

Operated by radio or cable control and monitored by closed-circuit TV, Mobot I is strong and gentle. Called "Fingers" by his friends, he can exert a 200-lb squeeze or handle delicate items with tweezer-like care. The sound of the metal fingers picking up objects is captured by a built-in microphone. Developed by Hughes Aircraft Co., Mobot can be equipped with a variety of tools for handling radioactive materials and equipment. He could be designed for underwater farming or for accompanying man on the conquest of the moon. He specializes in going where man can't.



Project to Develop Electric Auto Hinges Around Battery Design

DETROIT—A new look-see and development project on the electric automobile is aimed at the source of its limitations: The battery.

Announced jointly by American Motors Corp. and Sonotone Corp., the project will attempt to correct short life and excess size and weight of present experimental batteries.

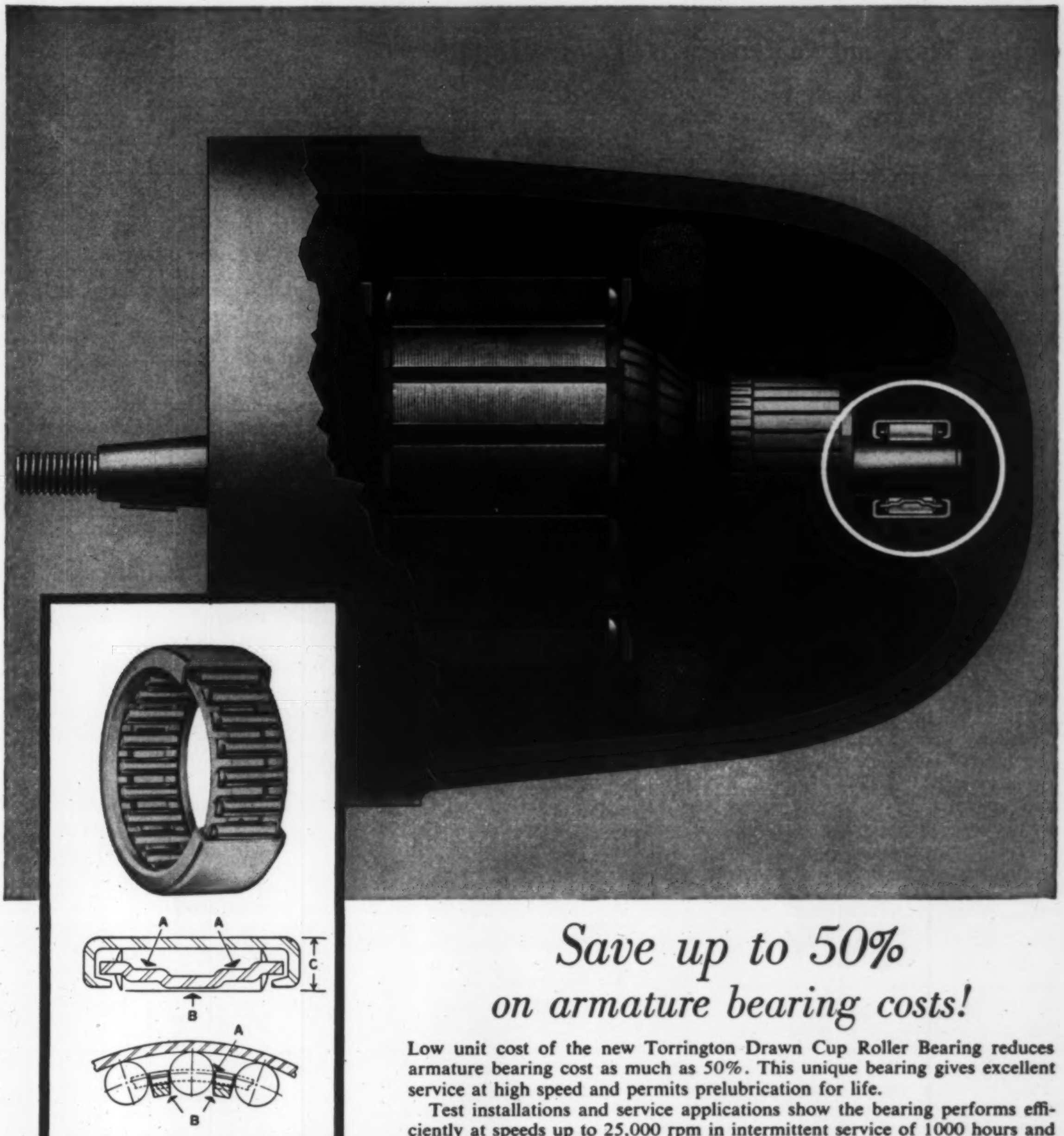
The sintered-plate nickel-cadmium battery of missile and jet-aircraft fame appears promising. Although expensive, the missile battery is smaller and lighter than conventional batteries of comparable output, can withstand great overloads and surges of current, and can be rapidly recharged — even during operation.

Presently, the chief drawback of electric autos is the need for recharging batteries after less than 100 miles of travel. Developing an electric powerplant capable of being recharged during operation is imperative to the success of the program. Recharging would be accomplished by a generator operated from a small high-performance engine.

Other goals of the highly speculative program include answers to fundamental questions of cost, economy of operation, performance, and vehicle size and weight. The program will require several years.

Transistor Sorter Lights Way To Proper Storage Bin

Plug in a transistor and this electronic machine will sort through its file of 1200 transistor characteristics to identify it. A light goes on to mark the proper sorting bin for the newly classified transistor. Using one of these machines for preliminary sorting to feed four more, developer Raytheon Mfg. Co., Waltham, Mass., can sort transistors from its production line into four main categories based on ultimate use—computer, general purpose, entertainment, or special—with variations in each category based on such qualities as: Alpha cut-off level, collector cut-off current at high and low voltage, "punch-through" voltage, emitter cut-off current at high and low voltage, minimum beta, and input voltage. The sorter works four times faster than previous methods.



- rollers end-guided at pitch line (A)
- shaft-riding retainer (B) designed to permit lubricant circulation
- high capacity in small cross section (C)
- long pregreased life
- efficient at high speeds
- mounted by press fit
- simple housing design
- low unit cost

Save up to 50%

on armature bearing costs!

Low unit cost of the new Torrington Drawn Cup Roller Bearing reduces armature bearing cost as much as 50%. This unique bearing gives excellent service at high speed and permits prelubrication for life.

Test installations and service applications show the bearing performs efficiently at speeds up to 25,000 rpm in intermittent service of 1000 hours and more. In such service, initial lubricant lasts the life of the motor. Most applications require no seals. This, with the simplicity of housing design, contributes further to economy.

Designers are invited to evaluate the Torrington Drawn Cup Roller Bearing for such applications as generators, power tools, electric mixers, vacuum cleaners and other appliance motors where considerations of cost, speed, efficiency and light weight are paramount.

Services of Torrington's engineering staff are offered to assist you in design developments of every type of electric motor. **The Torrington Company, Torrington, Conn.—and South Bend 21, Ind.**

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Design Show and Conference Will Draw 18,000

PHILADELPHIA—Four hundred companies will exhibit $10 million worth of products, and about 3000 experts will be on hand to answer questions for the expected 18,000 visitors when the Design Engineering Show opens a four-day run at Convention Hall, May 25. Research and development executives and engineers charged with planning the products of the 1960s will have an opportunity to study virtually every type of product and engineering service vital to their respective planning programs.

Exhibits will feature metal alloys, plastics, power transmission equipment, electrical and electronic components; all types of mechanical components; fasteners and adhesives; finishes and coatings; hydraulic and pneumatic components; engineering equipment and services; and virtually everything else that goes into the making of an industrial or consumer end product.

Concurrently with the show, an impressive four-day conference will be staged by the Machine Design Division of American Society of Mechanical Engineers. Sessions on two days will be devoted to general engineering problems, reports on design-engineering overseas, and the more effective use of engineers in industry. The remaining two days will cover specialized topics: Themes will be Materials, Power and Control, and Mechanical.

All sessions will begin at 9:30 a.m. in Convention Hall and finish in the forenoon, permitting members to attend the Show in the afternoon. Schedule for the Conference is as follows:

Monday, May 25

ENGINEERING DESIGN OVERSEAS

Engineering Design in Germany
. . . *Hellmuth Walter,* Director of Research, Worthington Corp., Harrison, N. J.

Tuesday, May 26

MATERIALS

Latest Developments in Plastics for High-Temperature Service
. . . *Irving J. Gruntfest,* Materials Studies, Aerosciences Lab., Missile and Space Vehicle Dept., General Electric Co., Philadelphia, Pa.

Latest Developments in Metals and Ceramics for High-Temperature Service
. . . *Julius J. Harwood,* Head, Metallurgy Branch, Office of Naval Research, Navy Dept., Washington.

POWER & CONTROL

Variable-Speed DC Drive Systems
. . . *M. H. Sluis,* Electrical Engineer, Pratt & Whitney Co. Inc., West Hartford, Conn.

DC Conversion Devices
. . . *J. J. Rheinhold,* Vice President, Richardson-Allen Corp., College Point, N. Y.

MECHANICAL

Design and Application of Belts, Chains and Gears
. . . *E. S. Cheaney, W. C. Raridan,* and *C. L. Paullus,* Principal Engineers, Product Development Div., Battelle Memorial Institute, Columbus, O.

Clutch, Fluid Coupling, Torque Converter: Application Considerations and Performance Comparisons
. . . *Robert W. Bachmann,* Application Engineer, Hydraulic Div., Twin Disc Clutch Co., Rockford, Ill.

Wednesday, May 27

MATERIALS

Latest Developments in Materials to Resist Chemical Corrosion
. . . *S. W. Shepard,* Materials Engineer, Chemical Construction Corp., New York, N. Y.

Latest Developments in Materials and Coatings to Resist Atmospheric Corrosion
. . . *E. Burt Friedl,* Principal Chemist, Corrosion Research Div., *Louis J. Nowacki,* Assistant Chief, Organic Coatings Research, and *William H. Safranek,* Assistant Chief, Electrochemical Engineering Div., Battelle Memorial Institute, Columbus, O.

POWER & CONTROL

Digital Systems for Control Applications
. . . *Isaac L. Auerbach,* President, Auerbach Electronics Corp., Narberth, Pa.

Logic Circuits for Machine Control
. . . *Edgar V. Weir,* Consulting Engineer, Magnetics Inc., Butler, Pa.

MECHANICAL

Design Curves for Journal Bearings
. . . *Donald F. Hays,* Research Engineer, Mechanical Development Dept., Research Labs, General Motors Corp., Warren, Mich.

Which Bearing and Why
. . . *Arnold O. DeHart,* Research Engineer, Mechanical Development Dept., Research Labs, General Motors Corp., Warren, Mich.

Thursday, May 28

GENERAL ENGINEERING

A Graphic Method for Engineering Organization
. . . *E. M. Ramberg,* Vice President—Engineering, Titeflex Inc., Springfield, Mass.

The Man and the Organization
. . . *Martin M. Bruce,* Director, Psychological Services, Clark, Channel Inc., Stamford, Conn.

Watch for the MD Show Guide

Again this year, MACHINE DESIGN will give its readers an advance look at the Design Show. The May 14 issue will feature a comprehensive Show Guide listing all exhibitors and many of their latest products. A floor plan of Convention Hall will be included showing location of each booth—to help show-attending readers cut down on their legwork. A synopsis of Conference papers will also appear. For further immediate information about the show and conference, hotels, or advance registration cards, write or wire the show's producer: Clapp & Poliak Inc., 341 Madison Ave., New York 17, N. Y.

New Computer Approaches Practical Speed Limits

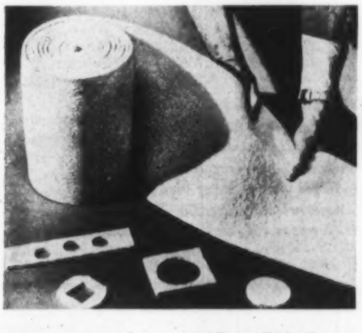
New York—Experimental computer circuits have operated at 500 megacycles in RCA laboratories. Spokesmen say this speed, which is 500 times that of presently used circuits, approaches the operating limit imposed by the speed of light. During one cycle at such a frequency, light would travel only 2 ft.

Microwaves, which travel at the speed of light, were used in the design of the experimental circuit. Each bit, in the binary system used, is composed of one wavelength with "zero" and "one" 180 degrees out of phase. Signals are read, amplified, and stored by a phase-locked oscillator that includes a small diode detector. The whole unit, together with gates and adders, is included in a printed circuit.

Key to the whole design, which was discussed by RCA researchers at the 1959 IRE meeting, is miniaturization of electronic circuits. Since electric impulses travel through wiring at less than the speed of light, too much wiring might lead to phase interference nullifying the whole system.

Silicone-Fiber Mat Challenges Sponge, Foam

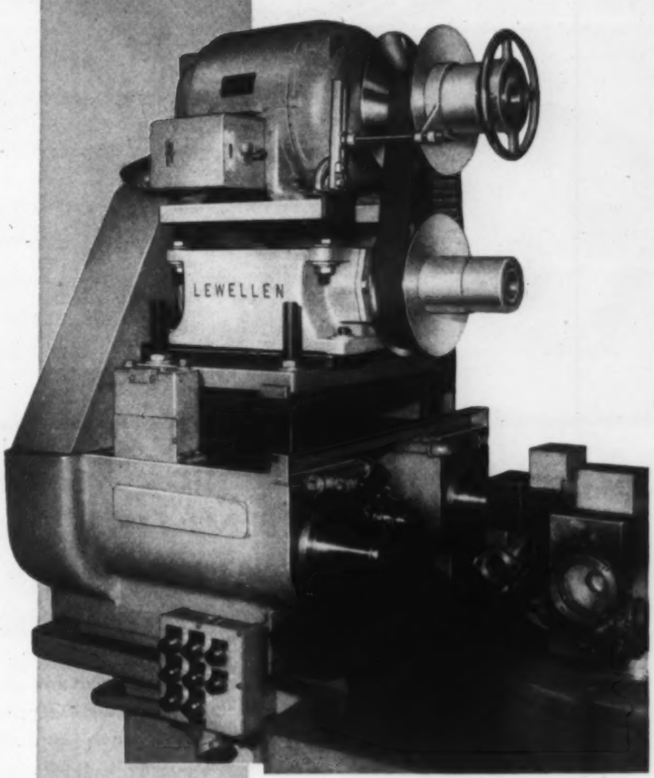
New Haven, Conn. — The latest development in silicones is a mat with silicone fibers randomly oriented. While similar in appearance to silicone sponge and foam, the mat reportedly has superior tensile and tear strength and high permeability. Temperature resistance ranges from −65 to 500 F.



According to Connecticut Hard Rubber Co., the superior properties are due to random fiber orientation.

LEWELLEN

VARIABLE-SPEED POWER PACK



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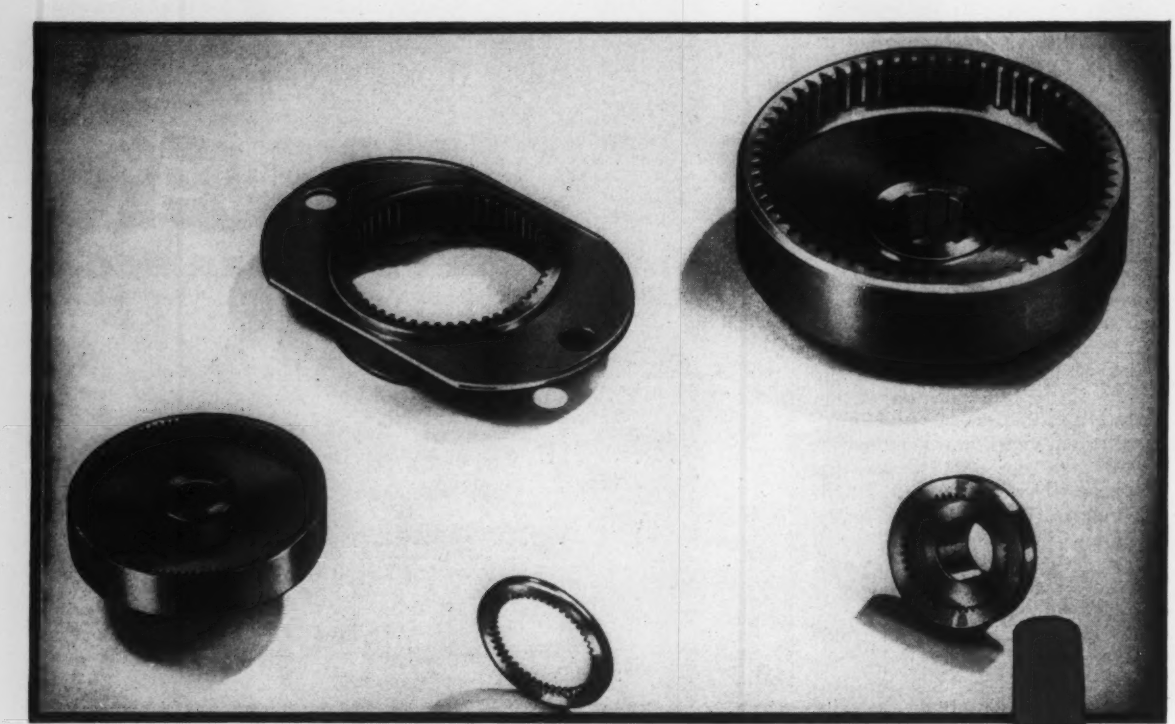

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G.S. Internals like those illustrated above, for example, are cut to exacting specifications for such applications as air operated hoists, floor machines, radio equipment, navigating instruments and many other uses. If you use Internals—or any other type of Small Gearing—get G.S. in your picture!

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Reader Information Service

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APR. 16, 1959

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421	451	481	511	541	571	601	631	661	691	721	751	781	811	841	871
422	452	482	512	542	572	602	632	662	692	722	752	782	812	842	872
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430	460	490	520	550	580	610	640	670	700	730	760	790	820	850	880

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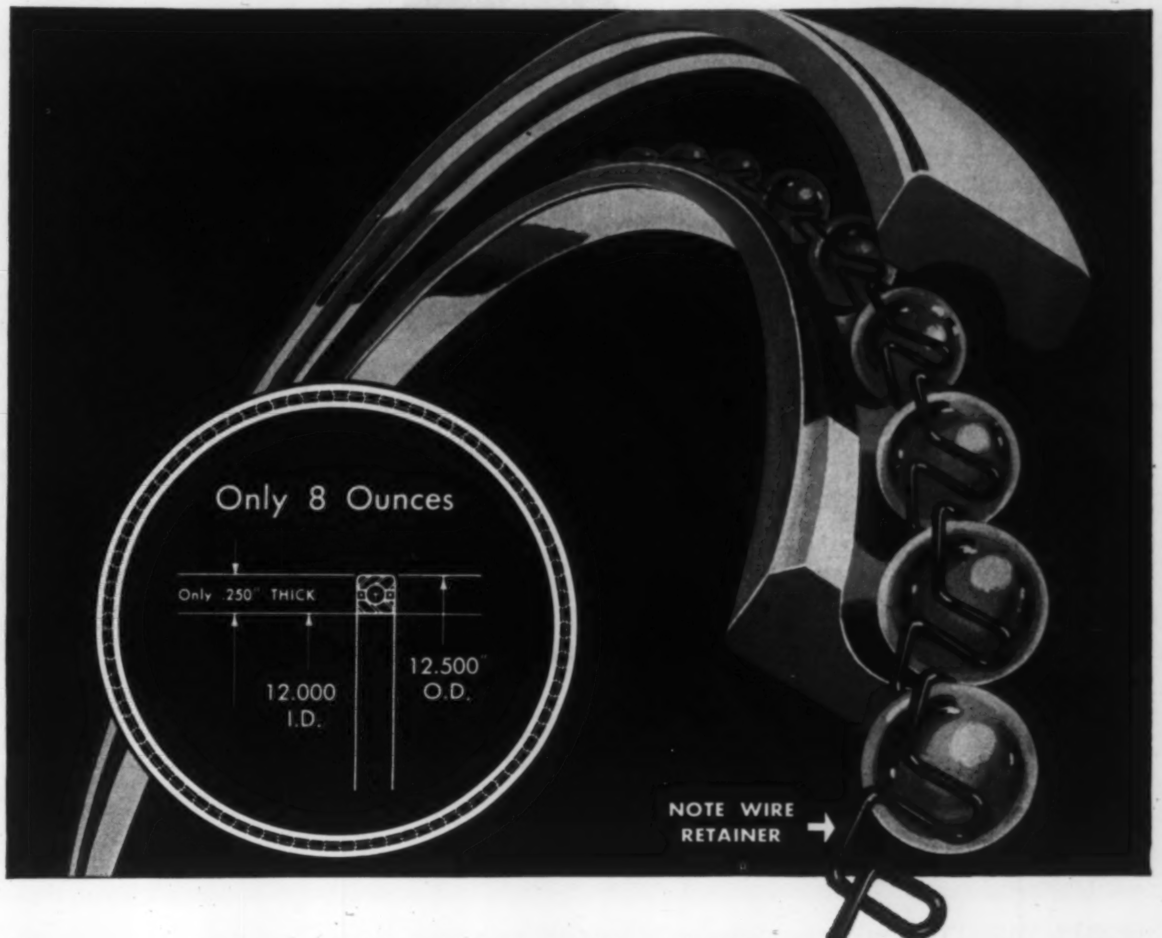


Save weight and space with world's thinnest radial ball bearings–*Reali-Slim* by Kaydon

. . . now carried in stock in 4" to 12" bores

HERE it is! A *Reali-Slim* radial ball bearing with a wire separator that has just short of a full complement of balls for maximum capacity. What's more, you still get all the advantages of a separator between the balls. This design also gives you a bearing that's light-in-weight and is, without a question, the thinnest bearing ever built in this diameter.

Whatever your product design, there's a small or large diameter *Reali-Slim* bearing that can be the right answer to your thin-section bearing problems.

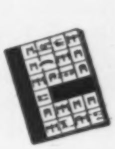
The radial ball bearing, illustrated here, is *really slim* — 12.000" I.D., 12.500" O.D., .250" thick . . . *and weighs only eight ounces.* It has 9,810 lbs. static load capacity, 1,256 lbs. at 100 rpm. Kaydon is able to produce *Reali-Slim,* high-precision bearings because Kaydon specializes in the unusual.

Kaydon bearing engineers are prepared to give you valuable help with technical, thin-section bearing problems.

For detailed information on Kaydon's *Reali-Slim* line, ask for engineering catalog No. 54-RS3 detailing:

Reali-Slim Ball Bearings — Conrad, angular contact and 4-point contact types in seven standard cross sections from ¼" to 1.000" and in bore diameters from 4" to 40".

Reali-Slim Roller Bearings — Radial and taper roller types in cross sections from $\frac{9}{16}$" and in bore diameters from 5" to 40".



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All types of ball and roller bearings — 4" bore to 178" outside diameter . . .
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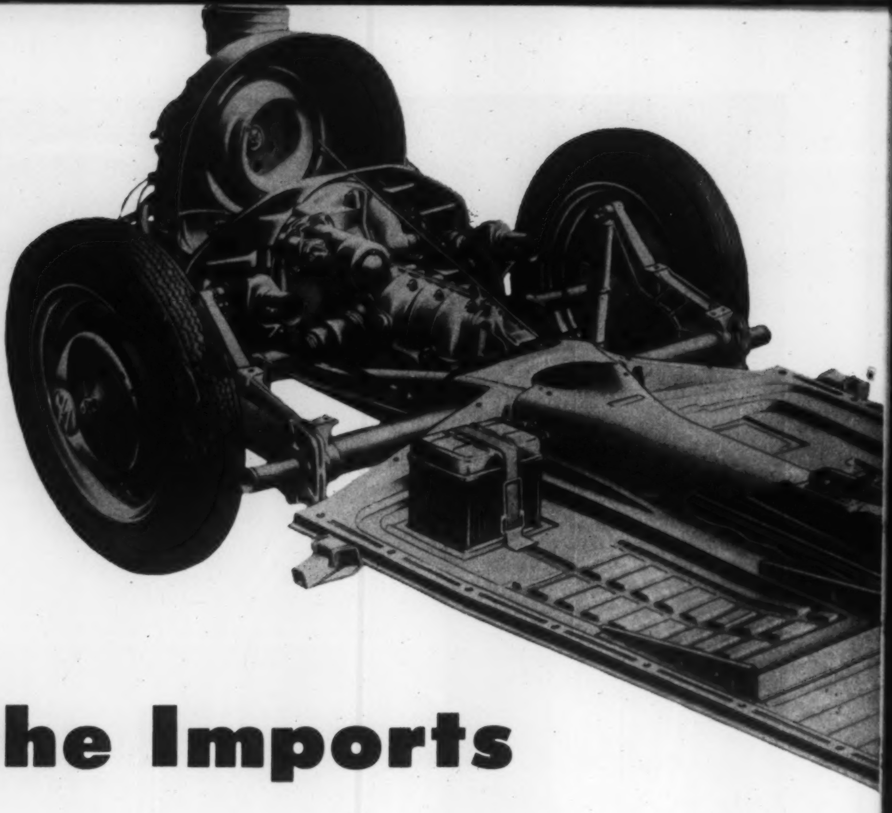


Racing and economy, an unlikely combination, have been the influencing factors in the design of European cars. Economy is obviously reflected in size, while the background in racing puts an emphasis on roadability. Here's a look at how European designers have matched these factors

Inside the Imports

DESIGN VARIETY seems to be a cardinal virtue in European carbuilding circles. Suspensions, brakes, steering gears, and even engine location vary widely among manufacturers. This adds up to one noticeable fact: Each car has a distinct personality.

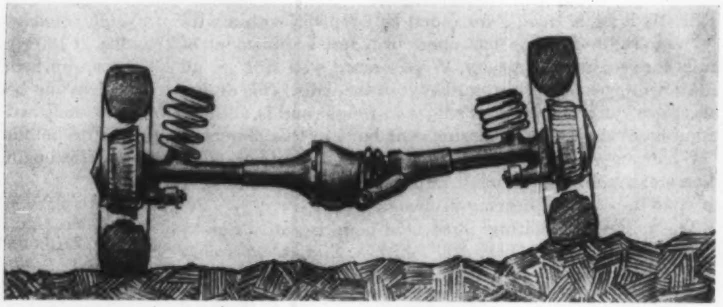
Driving an import for the first time, the typical American-car owner may be impressed by the idiosyncrosies of high-rate steering, a "robust" suspension system, front-wheel drive, or a rear-mounted engine. These and other mechanical features, and how they effect car-handling qualities, are described on the following pages.

Suspensions

Suspension systems have two jobs to perform: 1. Provide maximum passenger comfort consistent with safety. 2. Keep the vehicle's wheels on the ground.

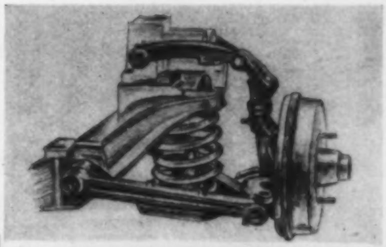
European designers, in favor of keeping their wheels on the ground, resort to rather rigid springing. Push down on the front end of any American car and the body rocks gently. Do the same with a small European car and unless the ground gives there is no noticeable deflection. This factor is desirable in a lightweight car, and is a great consolation during high-speed maneuvering.

Almost all European production cars now use independent front suspension systems: Upper and lower



Unsprung-weight reducer . . .

Single-joint swing axle and coil springs give Mercedes cars exceptional road-holding qualities. Unsprung weight is reduced drastically with this system. Also of significance: Increased trunk space. The axle is positioned by means of longitudinal control arms, and is restricted laterally by attachment of differential to chassis. The design was first proved on Mercedes racing cars.



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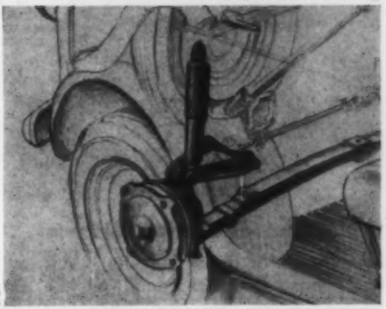

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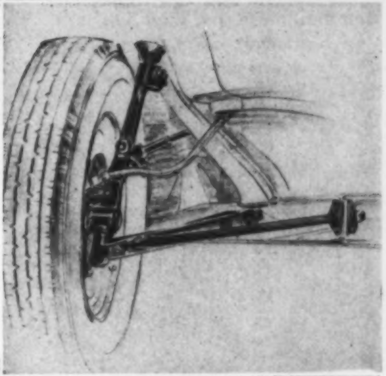

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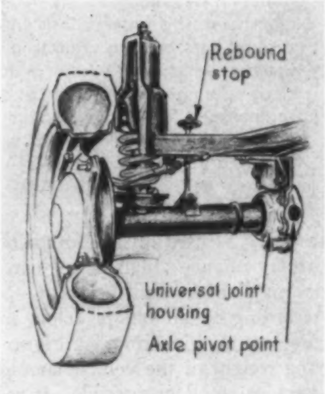

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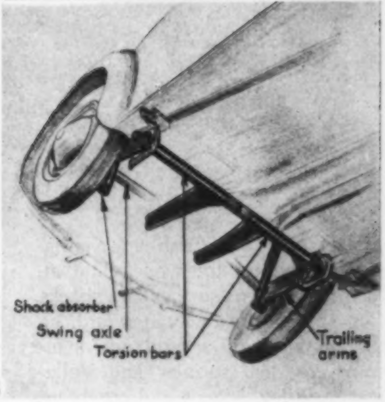

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Suspensions are firm . . .

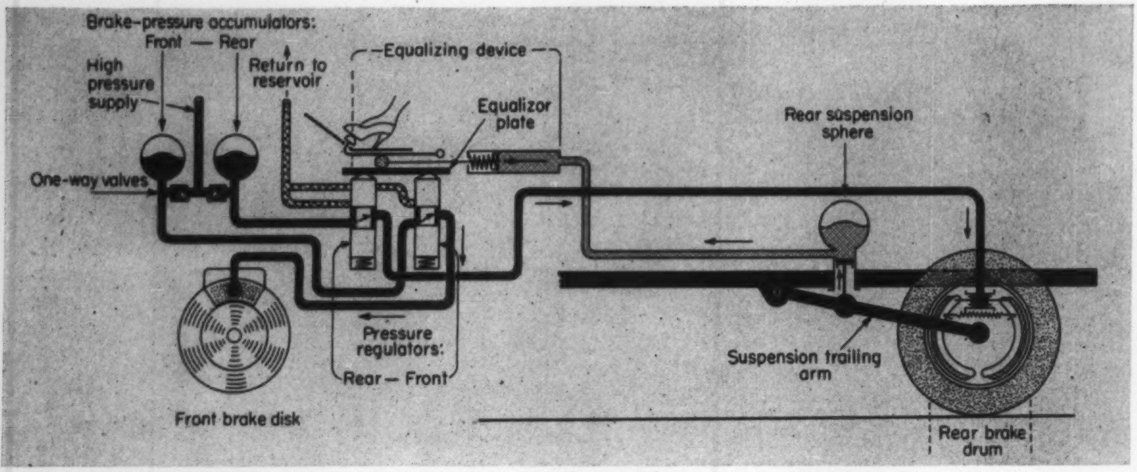
1 Unequal-length wishbones plus a coil spring controlled by telescopic dampers (hydraulic shocks), make up the most popular front suspension system in the smaller European cars.

2 Transverse leaf spring connected to the body at two points suspends the front of the Fiat 500. The spring also acts as a stabilizer during asymmetric actions of the wheels.

3 Torsion-bar front suspension gives the Riley One-Point-Five an exceptionally firm ride and excellent cornering characteristics. Telescopic dampers form the upper suspension link.

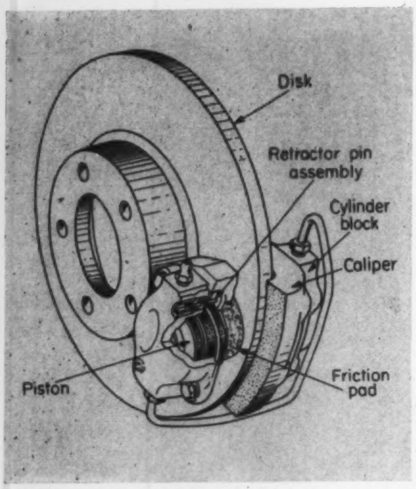
4 Coil springs and swing axles are used in the Renault Dauphine's rear suspension. Since Dauphine is a rear-engine car, swing axles were considered necessary to allow compact mounting of engine, transmission, and differential.

5 Torsion bars, instead of coil springs, are combined with swing axles in Volkswagen's rear suspension. The bars are supported at the center of the frame and connected by swing braces to the axle shafts, giving each wheel independent suspension. Vertical motion is controlled by shock absorbers.



Drums and discs stop Citroen . . .

Front and rear brake pressure is distributed automatically, according to axle loading, on the Citroen DS-19. The unique system uses disc brakes on front wheels (better braking for Citroen's front-wheel drive) and drums in the rear. Pads and shoes are activated by pressure from two hydraulic accumulators on independent circuits.



First for Jaguar . . .

Disc brakes, designed by Dunlop Rubber Co. Ltd., were pioneered on Jaguar racing cars. Brake disc, which is attached to the hub, rotates with the wheel. The caliper, rigidly fixed to the axle, carries two hydraulic cylinders, each containing a piston and a circular pad of friction material. Location of the pads on either side of the disc insures thermal balance and protects the disc from stresses imposed by axle movement. This fosters consistent, straight-line braking. Retraction devices which hold the pads clear during nonbraking also compensate for wear. Maintenance is thus minimized and the brakes are virtually trouble-free.

control arms in a wishbone configuration support the wheels and attach to the front springs and shocks. Coil springs are fairly standard, although Fiat and several others use transverse leaf springs, and Volkswagen, Riley, Morris and others use torsion bars. The torsion-bar system is exceptionally firm and gives excellent cornering qualities.

Rear suspensions also differ widely among the imports. A majority use a live rear axle, where axle and differential are one unit. Springing is done with either coil or leaf springs. Popular with manufacturers because of its low cost, the live axle arrangement is also considered satisfactory by many engineers in the industry. It is used on a number of high-performance high-price cars, including Jaguar and Ferrari.

According to an old principle in automotive engineering, the unsprung weight of the vehicle should be kept as small as possible—it reacts at the time of deflection against the sprung weight and is a definite factor in control of the vehicle when passing over bumps, particularly on curves. Basically, by reducing unsprung weight, designers can reduce wheel bounce, and softer suspensions can be used to keep the wheels on the ground.

For this reason, the more exotic rear suspensions, in the form of swing axles, are steadily gaining in popularity. Daimler-Benz pioneered with swing axles, and uses a single-joint unit on its limousines and sports cars. Volkswagen, Porsche, and Renault's Dauphine also use a species of the swing axle.

Steering

Rack and pinion, one of the most common steering methods used in the imports, adds to the small-car driver's "feel of the road." It gives positive action—2½ turns of the steering wheel from stop to stop is about average—and works well on light cars where little force is needed to turn the wheels. However, for rack and pinion to be free from road effects (feedback as a result of high reverse efficiency), it has to be used with almost a center-point steering layout.

Stopping

Disc brakes represent one of the most spectacular developments in European car design during the past 5 years, but they are still used almost exclusively on the sports models. Most passenger cars, large and small, continue to use conventional drum brakes. Cost obviously is the factor, since discs offer impressive advantages: Fading due to heat is virtually eliminated; disc pads automatically compensate for wear and are easily replaced without bonding or riveting; and water has no effect on disc-braking efficiency.

Primer on Roadability

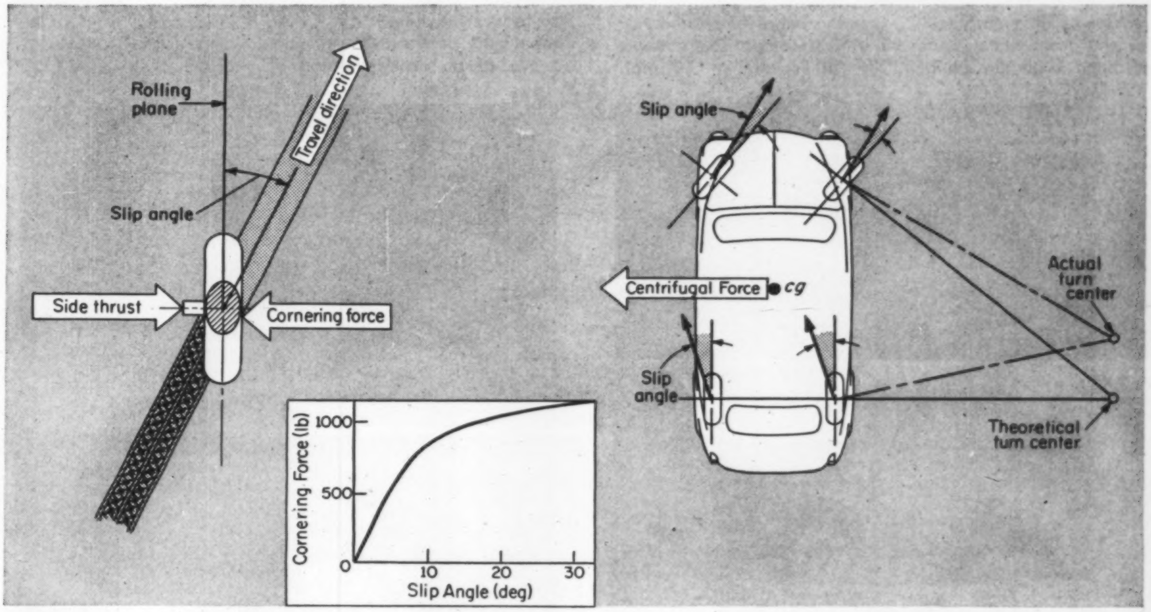
Loyalty often compromises objectivity when the small-car enthusiast is asked to appraise the "road manners" of his vehicle. He may dispose of a question on cornering behavior with, "She turns on a dime!" Or perhaps he quotes the catalog on the small number of turns required of the steering-wheel for stop-to-stop action. Quizzed on oversteering or understeering tendencies, he may suspect a poorly camouflaged jibe at his driving abilities.

Because behavior of a vehicle in motion is complex, the nonprofessional driver can be pardoned for not grasping all the physical implications of small-car handling and stability. Unaccustomed to the novelty of lightweight, short-wheelbase imports, he may jump to the conclusion that *all* small foreign cars "feel better" on the road than made-in-Detroit products. Since the nonprofessional seldom intentionally exceeds limiting values on cornering or stability, he usually finds no reason to regret this conclusion.

Designers of imported cars, in common with their American cousins, are aware that their vehicles (small or large) should overtax neither the reflexes nor the judgment of the average driver. There is general agreement that *handling-quality* evaluation is a strictly personal judgment, one compounded of the total impressions of a fairly skilled driver on how the vehicle responds to directional commands. *Stability* is viewed as a dynamic property that describes the manner in which a vehicle holds its course after it has been disturbed. Obviously, handling qualities and stability that are tailored for road-racing vehicles would, if built into an "everyday" car, make for an exciting Sunday drive.

Unlike American automobiles—made in only a handful of distinct types and all employing front-engine, rear-wheel drives—imported cars cover the design spectrum of engine location, drive configuration, and size. Arguments between proponents of rear-engine and front-engine mounting are as heated as ever. Brisk sellers like VW, Renault, and Fiat—which incorporate new lightweight engines—are justifying longstanding claims that location of the engine in the rear need not compromise road behavior. However, appearance of Saab and Citroen in U. S. markets has revived interest in the traditional (and sometimes exaggerated) virtues of the front-wheel-drive. Both cars offer unique "road experiences" to U. S. drivers.

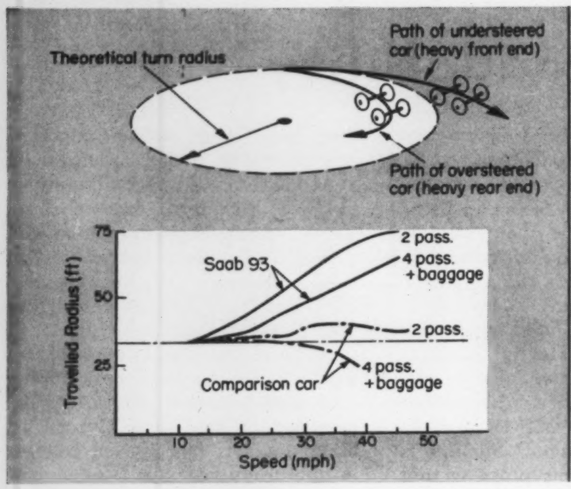
Starting with an examination of the slip-angle forces developed by a rubber tire, sketches that follow serve as a guide to the potential import-car owner who is trying to thread his way through conflicting claims and counterclaims on roadability in import-car sales literature.

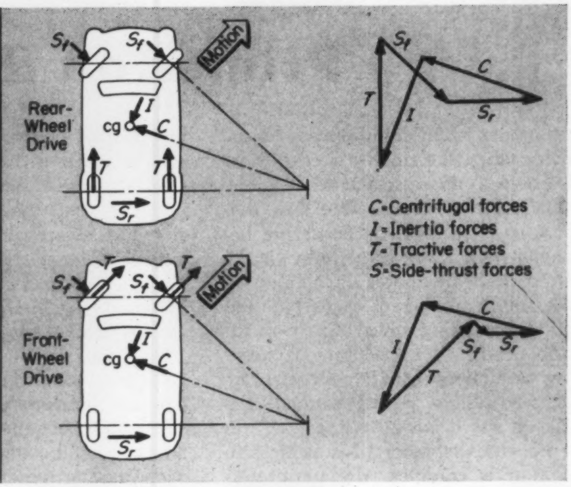


Progress on the bias . . .

Pure rolling of rubber-tired wheels occurs only when the vehicle rolls straight ahead, free of side-force disturbances. When side thrusts act (because of centrifugal effects, side winds, etc.), the tire counteracts with an elastic cornering force, and the wheel path deviates from the pure-rolling plane by a slip angle proportional to the cornering force.

Actual center of rotation of a vehicle negotiating a curve seldom coincides with the theoretical center. The shift is brought about by a difference between slip angles of front and rear wheels. The effect is more pronounced in a vehicle with unequal fore-and-aft weight distribution, and has a strong influence on directional-stability characteristics.





Road manners are built-in . . .

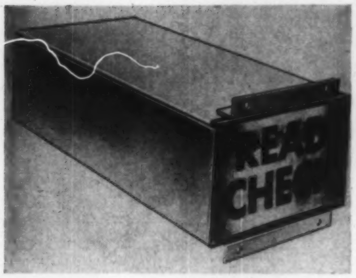
Understeering or oversteering—which is a vehicle trait that is independent of driver skill—is largely predetermined when the vehicle design cg is fixed. Naturally, positioning of passenger and baggage loads will modify such steering tendencies. Oversteering, evidenced by outward drift of the rear end when a vehicle negotiates a curve, is most pronounced when rear-wheel slip angles greatly exceed those on the front. Because the effect is self-increasing (centrifugal force constantly builds up), radical oversteering tendencies are avoided by holding design weight on rear axles to about 60 per cent of curb weight. Understeering, which leads to widening of the curved-path radius, is generally considered a stabilizing trait for vehicles designed for drivers of average skill. Steering behavior plotted here for the front-wheel Saab 93 and a comparison car was obtained with an initial 30-ft radius turn at 10 mph.

Use power with care . . .

Traction forces accelerating a rear-wheel drive car act in the direction that increases side-force reactions on the wheels. In contrast, tractive forces on the accelerating front-wheel drive car are aligned with the rolling direction and considerably reduce side-forces. The front-drive car may "feel" better to the average driver because application of power tends to increase understeering characteristics. However, added power compromises cornering capacity of driving wheels (front or rear), and both front and rear-drive cars will eventually leave the road at approximately the same speed. A factor affecting efficiency of front-drive vehicles is found in the dynamic weight shift away from the front wheels during accelerated motion. The effect is to reduce maximum transferable tractive force, thus cutting maximum acceleration. Dynamic weight shift is likely to prove to be academic with the lower powered imports.

Weight is a family trait . . .

Described as understeerers, front-drive cars like the Saab 93 (top left) and the Citroen DS-19 (top right) are heavier on their front wheels when empty. Slight oversteering tendencies of rear-engine imports like the Renault Dauphine and the Fiat 600 (bottom left and right) are counteracted by carefully designed suspension and steering geometry. Weight distributions (empty) for the four cars are: Saab: front—57%; rear—43%. Citroen: front—65%; rear—35%. Renault: front—39%; rear—61%. Fiat: front—42%; rear—58%.



Display Stores Twenty Messages

Up to twenty messages—all stored full-width on a common "lenticular" viewing plate—are displayed one at a time by a Burroughs Corp. multi-message unit. The unit uses no projection or focusing lenses. Instead, an individual message is activated when one of twenty miniature point-source bulbs is lighted. Burroughs' Electronic Tube Div. makes the multiple-message display by photographically exposing the 3 by 5 in. lenticular screen with point sources arranged at angles corresponding to those in the display unit itself. The device will also display digits, charts, and photographs—in black and white or color.

Air Jet Senses Missing Drills

Absence of a drill is detected pneumatically by a new device designed for use with single or multiple-station automatic drilling machines. A jet of air is directed at the drill as it enters and retracts from the workpiece. If the drill doesn't go deep enough to intercept the sensing head (broken or missing), a pressure drop occurs in the air jet's pneumatic circuit. This initiates an electrical impulse to operate signal lights and shut-off relays. Developed by the Sheffield Corp., Dayton, Ohio, the air jet serves a dual purpose by keeping drills clean and free of chips.

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Solenoid Valves

Filters

Check Valves

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Waterman Series 190 pressure compensated flow regulators are the simple, straightforward way to be sure of constant cylinder speed, regardless of load. Factory-set to your specifications, factory-tested for precise calibration. Easiest of all to design into a system, because they require no access for adjustment, take little more space than the pipe or tubing that they replace. Rated at 3000 p.s.i., controlled flow rates from 0.1 to 100 g.p.m. Matched pairs and sets available.

Series 190 is just one of many Waterman types that make up the most complete line of hydraulic flow regulators—fixed and adjustable. Specify Waterman for flow control and be *right—from the start.*

W-5908

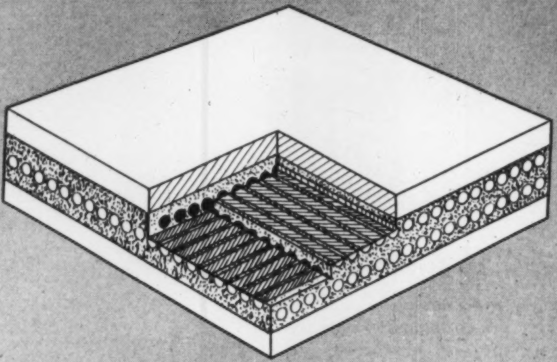
Waterman representatives are in all principal cities. Write for Waterman Flow Regulator Catalog No. 1000, and for Waterman Solenoid Valve Catalog No. 2000.
Also suppliers of AN and MS qualified flow regulators and fuses.

Waterman Engineering Company, 725 Custer Ave., Evanston, Illinois

WATERMAN
ENGINEERING COMPANY

Circle 414 on Page 19

Sensitive electronic and mechanical components are protected from vibration and shock by a new "mattress" of Teflon rods supported in a matrix of silicone rubber. Friction at interfaces of Teflon and rubber damp out shock and vibration to make . . .



Cushions for Components

By R. H. JACOBSON
Armour Research Foundation
Illinois Institute of Technology

A UNIQUE MEDIUM for protecting electronic equipment against shock and vibration has been developed by Armour Research Foundation, Chicago, Ill., for Wright Development Center. The medium is composed of a multilayer grid of Teflon rods imbedded in a matrix of Silastic (silicone rubber). Its outstanding feature is high internal damping, produced by friction at the Teflon-Silastic interfaces.

Specifications to be met in designing the new material included:

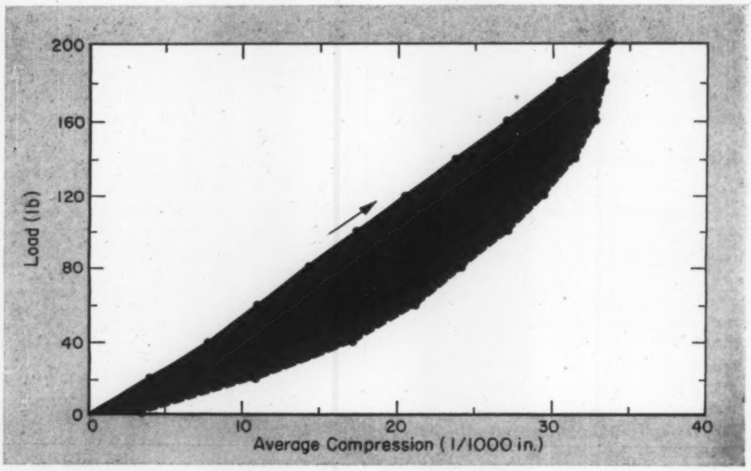
- Maximum vibration transmissibility: 1.5
- Operating temperature range: −85 to +482 F
- Shelf life: 5 years

Numerous other requirements set by WADC specified physical characteristics, resistance to environmental changes, and cost.

In the design of the cushion medium, internal damping was considered most important for effective shock and vibration protection. After a number of candidate materials that satisfied general environmental requirements were found, specimens using these materials in various configurations were made. Specimens were compared for internal damping characteristics, and new refined versions of the best were tested. In all, more than 50 specimens representing four or five different approaches were made and tested. Promising performers were examined to find how they met other requirements. The best of the lot turned out to be a specimen incorporating a three-

Materials vs. Environment

Condition	—Effect on Materials—	
	Silastic	Teflon
Salt spray	None	None
Prolonged storage	None	None
Reduced pressure	None	None
Humidity	Negligible	Negligible
Fungus	Negligible	Negligible
Hydrocarbons	Swells	Negligible
Combustion	Burns when ignited	Does not burn



Area between compression and spring-back lines indicates high degree of internal damping in grid-matrix combination.

He cooked up a solution on Liberty Stoves...

Riveting porcelain switches let 1 girl do the work of 6

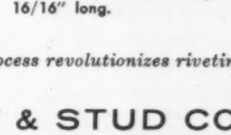
"You don't need to tie up six girls on slow, costly, nut-and-bolt assembly of porcelain switches to this mounting plate. You can do it on an automatic riveter . . . with one girl, low cost rivets, and no switch breakage . . ."

This was the TRS sales engineer's solution to the problem of Liberty Electric Co., Inc., Indianapolis, maker of fine electric table stoves. He had the rivet and machine know-how to work out the answer . . . an answer that saved five-sixths of the labor.

Let the TRS man look over your assemblies. You'll find that he has the viewpoint of a manufacturing engineer, and an unusual knack for making fastening simpler, faster, better.

Of course he will recommend TRS rivets. But he will give you sensible reasons why they are more reliable in essential qualities and uniformity. Ask to see the TRS Quality Control Album . . . one significant result of a five-year modernization of this pioneer company. Modernization of people, policies, production and service facilities. *You'll like to do business with the new TRS . . . we'll make sure of it.*

THE TRS MAN'S SOLUTION



Pneumatically powered, long stroke TRS riveter, adjustable for precisely controlled "cushioned" setting of semi-tubular rivets up to .160" body diameter by 16/16" long.

Don't Buy Riveting Machines until you learn how the TRS **PAR** *process revolutionizes riveting*

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TUBULAR RIVET & STUD COMPANY

QUINCY 70, MASSACHUSETTS • **TRS** SALES OFFICES: Atlanta • Buffalo • Charlotte • Chicago
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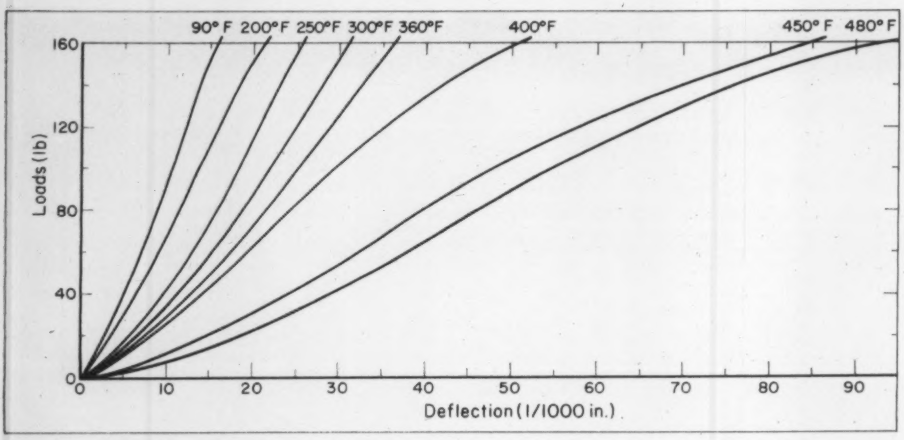
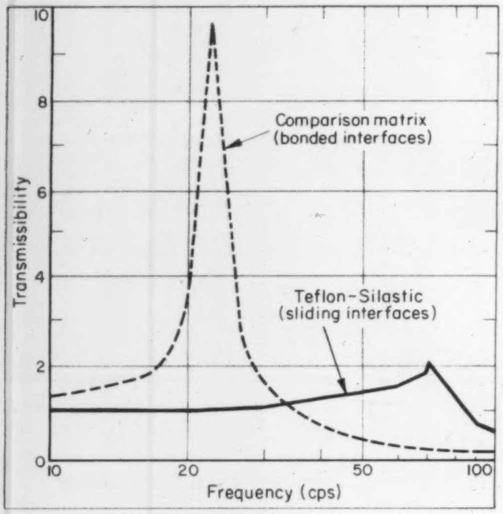
See "Yellow Pages" for phone numbers.

If it's a Tubular Rivet TRS makes it . . . and Better

Circle 415 on Page 19

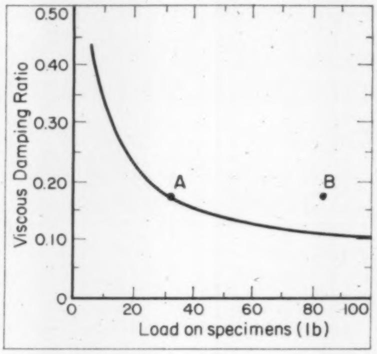


Deflection curves for various temperatures show stiffness decreases as temperature rises. Deflection at 480 F is more than six times that at 90 F for the same load.



Internal damping of grid-matrix configuration using Teflon and Silastic S6508 is compared to another specimen using different materials. High degree of damping in Teflon-rubber specimen is due to absence of an adhesive bond between the two materials. This causes sliding interfaces which produce damping.

Viscous damping ratio as a function of load. Curve shows relationship expected with ideal substance. Composite panel of Silastic and Teflon have no correlation (Points A and B).



layer grid of $3/8$ in. diam Teflon rods in a matrix of Silastic S-6508.

The cushion material comes in flat slabs. In a typical application, it can be cut to size and wrapped around the circumference of a cylindrical piece of equipment, and the assembly secured by straps or brackets.

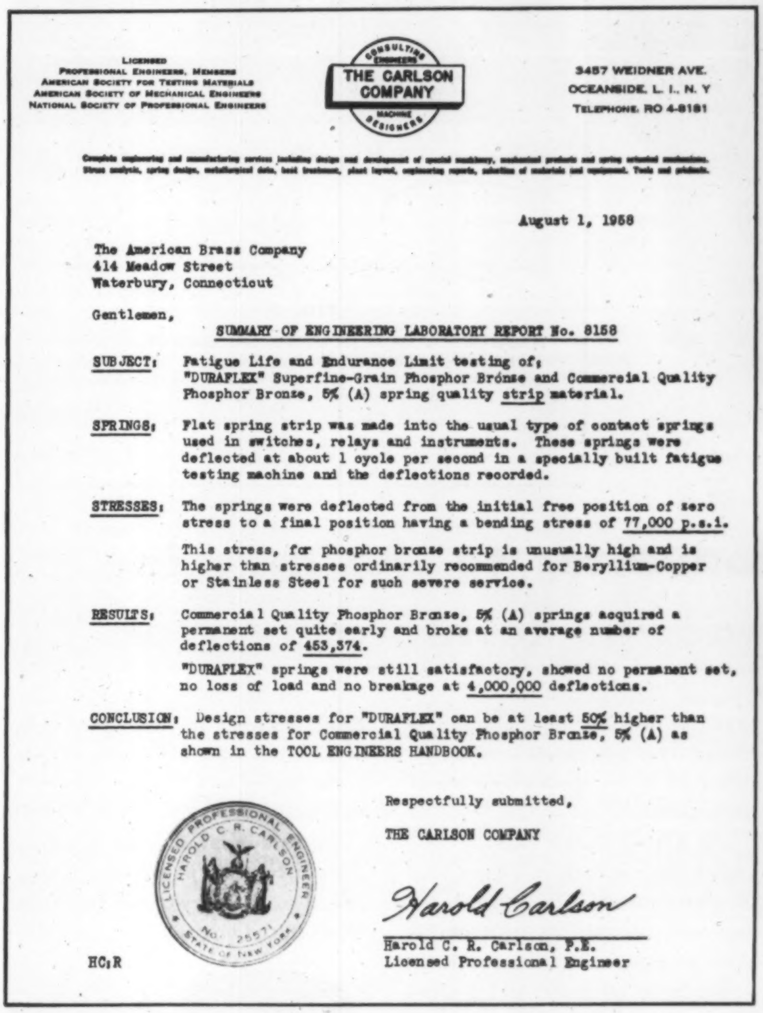
The Teflon-rubber medium was found to be stronger in compression than in either tension or shear. In compression, a 3 by 3 in. specimen withstood a load of 1560 lb. It is anticipated that the medium will be applied so that part of it is always under compression, and, if desired, preloading can be applied to place all of the medium under compression.

Stiffness of the composite material is such that, for a 33-lb load acting on a 3-in. square sample $1/2$ in. thick, a natural frequency of approximately 60 cps is obtained. This frequency is nearly midway in the 15 to 100 cps range specified and is close to the 50-cps natural frequency recommended by one aircraft manufacturer for passive equipment.

Dynamic response of the matrix-grid medium differs from that of an ideal linear single-degree-of-freedom damped system. For an ideal system, where critical damping equals $(KM)^{1/2}$, the damping ratio, and hence the maximum transmissibility, varies with the isolated mass of the system, M. For the new medium, no significant change of equivalent viscous damping ratio was observed when the load representing the isolated mass was changed from 33 to 85 lb.

Manufacturers of materials in the new medium designate serviceable temperature of -100 F to $+500$ F and -290 F to $+500$ F for the Silastic S-6508 and Teflon, respectively. Thus, both materials are capable of withstanding the temperature range specified. However, it was found that, although no deterioration in the medium was produced by extreme temperatures, its stiffness decreased as temperature was raised. At 480 F, deformation was more than six times as great as that produced by an equivalent load at 90 F. At -57 F, deformation was 80 per cent of that at $+85$ F. Similarly, vibration transmissibility tests revealed that, as temperature increased, the resonant frequency decreased (reflecting the loss of stiffness) and the maximum transmissibility increased. Maximum transmissibility ranged from 1.55 at -55 F to 2.60 at $+495$ F.

SPRING STRESSES that formerly required premium-priced materials can now be handled by Duraflex,® which costs no more than regular phosphor bronze. Write for literature and samples, today.



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THE CARLSON COMPANY
MACHINE DESIGNERS

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OCEANSIDE, L. I., N. Y
TELEPHONE RO 4-8181

August 1, 1958

The American Brass Company
414 Meadow Street
Waterbury, Connecticut

Gentlemen,

SUMMARY OF ENGINEERING LABORATORY REPORT No. 8158

SUBJECT: Fatigue Life and Endurance Limit testing of; "DURAFLEX" Superfine-Grain Phosphor Bronse and Commercial Quality Phosphor Bronze, 5% (A) spring quality strip material.

SPRINGS: Flat spring strip was made into the usual type of contact springs used in switches, relays and instruments. These springs were deflected at about 1 cycle per second in a specially built fatigue testing machine and the deflections recorded.

STRESSES: The springs were deflected from the initial free position of zero stress to a final position having a bending stress of 77,000 p.s.i.

This stress, for phosphor bronse strip is unusually high and is higher than stresses ordinarily recommended for Beryllium-Copper or Stainless Steel for such severe service.

RESULTS: Commercial Quality Phosphor Bronse, 5% (A) springs acquired a permanent set quite early and broke at an average number of deflections of 453,374.

"DURAFLEX" springs were still satisfactory, showed no permanent set, no loss of load and no breakage at 4,000,000 deflections.

CONCLUSION: Design stresses for "DURAFLEX" can be at least 50% higher than the stresses for Commercial Quality Phosphor Bronze, 5% (A) as shown in the TOOL ENGINEERS HANDBOOK.

Respectfully submitted,

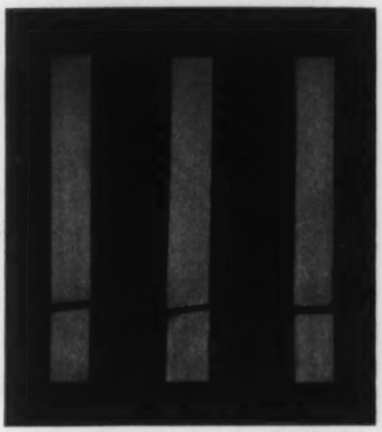
THE CARLSON COMPANY

Harold Carlson

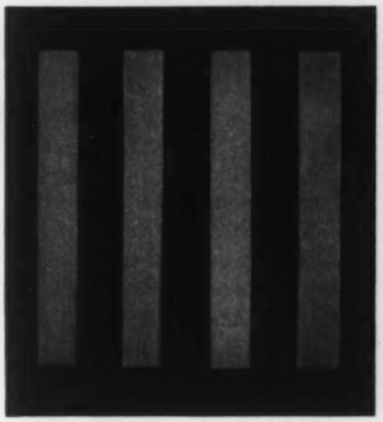
Harold C. R. Carlson, P.E.
Licensed Professional Engineer

No. 25571

HC:R



THREE SPRINGS of regular Phosphor Bronze, 5% (A), actual size, took a permanent set at about 200,000 deflections and fractured at an average of 453,374 deflections.



FOUR SPRINGS of Duraflex Superfine-Grain Phosphor Bronze, 5% (A) were still satisfactory after 4,000,000 deflections.

DURAFLEX, available in Phosphor Bronzes (A), (C) and (D), in strip and wire, offers a host of opportunities to cut costs while maintaining or improving quality and performance. For further information and technical help to select the alloy to meet your needs—call in your American Brass Company representative, or write: The American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ont.

5938

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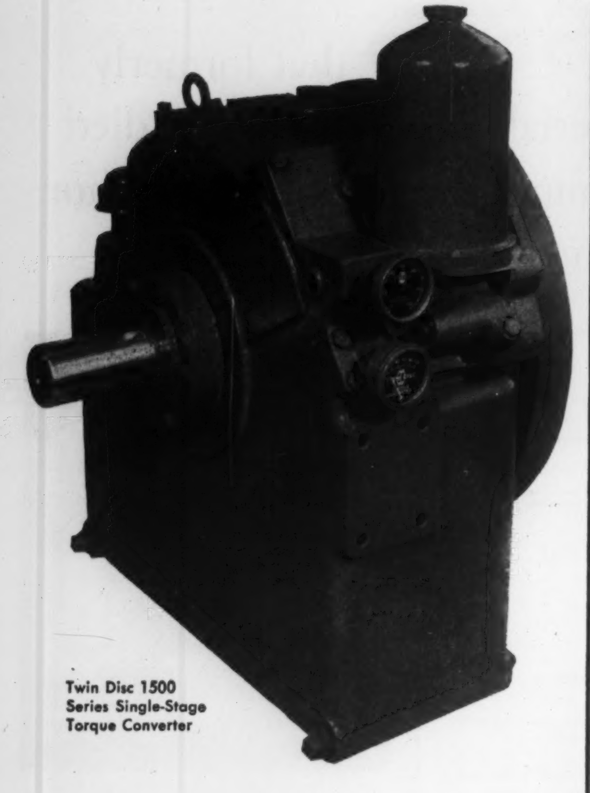

Twin Disc 1500
Series Single-Stage
Torque Converter

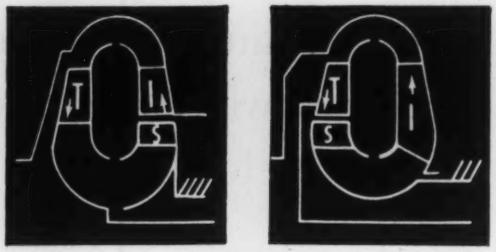

FIG. 1

Schematic drawings of the two types of single-stage circuits. The Type 1 (outflow) circuit is at left. Type 6 (inflow) is at right.

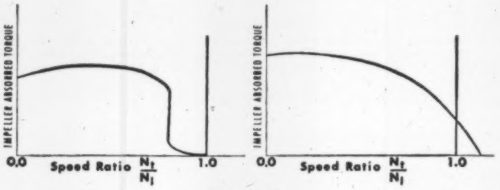

FIG. 2

A comparison of the torque characteristics of the Type 1 circuit (left) and the Type 6 circuit. The Type 1 circuit unloads the engine quite abruptly at a speed ratio of about .825. The Type 6 design allows a no-load speed ratio of 1.15:1.

Match the converter to the machine ...not the machine to the converter!

Twin Disc offers its customers the choice of two different circuit designs in each series of single-stage torque converters. The two circuit designs fit within the same housings since the circuits have the same basic dimensions. Each circuit has, however, distinctly different performance curves enabling machine designers to:

Match the converter to the machine
NOT
the machine to the converter

Figure 1, above, shows schematic sketches of each circuit. Both have the identical pear-shape convolution, the principal apparent difference being that the position of the stator is shifted. This shift causes considerable difference in the absorbed torque of the impeller.

The Type 1 design "unloads" the engine quite abruptly at a speed ratio of approximately .825. In effect, the converter becomes its own output shaft governor. Since the circuit absorbs almost no power at 1:1 speed ratio, a lock-up clutch between the turbine and pump may be incorporated in the mechanical design.

Where applications require a broader speed range in converter drive, the Type 6 circuit is recommended. As shown in Figure 2, this design allows a no-load speed ratio of 1.15:1. Torque absorption at stall is also higher, which results in higher stall torque up to 3.5:1.

For further information as to how these circuits can be adapted to your particular design, write or call Twin Disc Clutch Company.

TWIN DISC
CLUTCHES AND HYDRAULIC DRIVES

TWIN DISC
Torque Converters

TWIN DISC CLUTCH COMPANY, Racine, Wisconsin (Hydraulic Division) Rockford, Illinois

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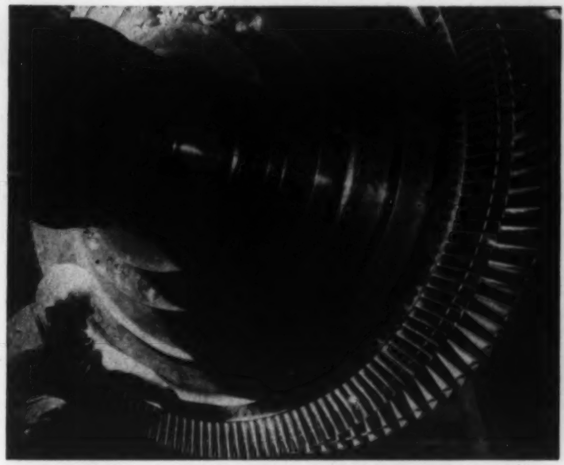
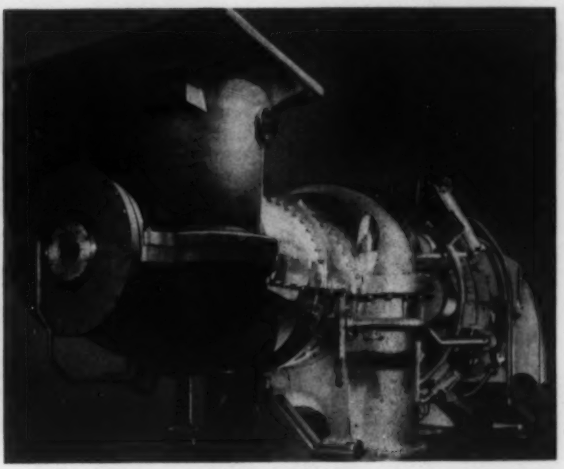
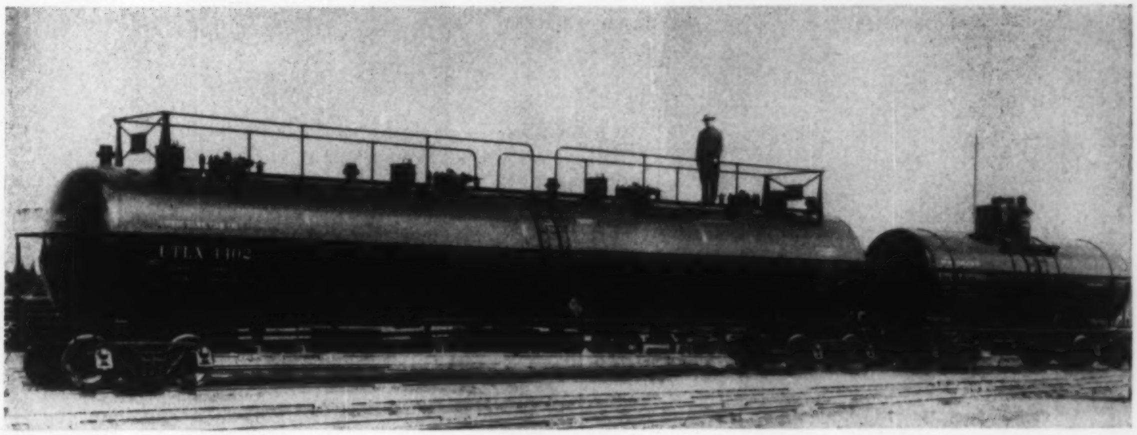




Gas Turbine Powers Standby Generator

An axial-flow gas turbine, says GE, is the most economical solution for standby peak-load power requirements at electric power stations. Up to now, the practice has been to relegate outmoded steam or internal combustion units to standby service as newer units replaced them. Where it may take half a day to warm up one of these older units, the General Electric turbine, rated at 20,500 kw, is ready to go into service in 20 minutes.



Texas-Size Tanker

Bigger, but less costly than two ordinary tank cars, this long unit will also cut costs in loading, unloading, and car handling. Called the world's largest, it's the first of four being built by Union Tank Car Co. and is constructed according to Union's so-called "hot dog" design. Conventional underframe is eliminated by welding the tank directly to the wheel trucks. Length of the car is about 68 ft and capacity is 21,800 gal.

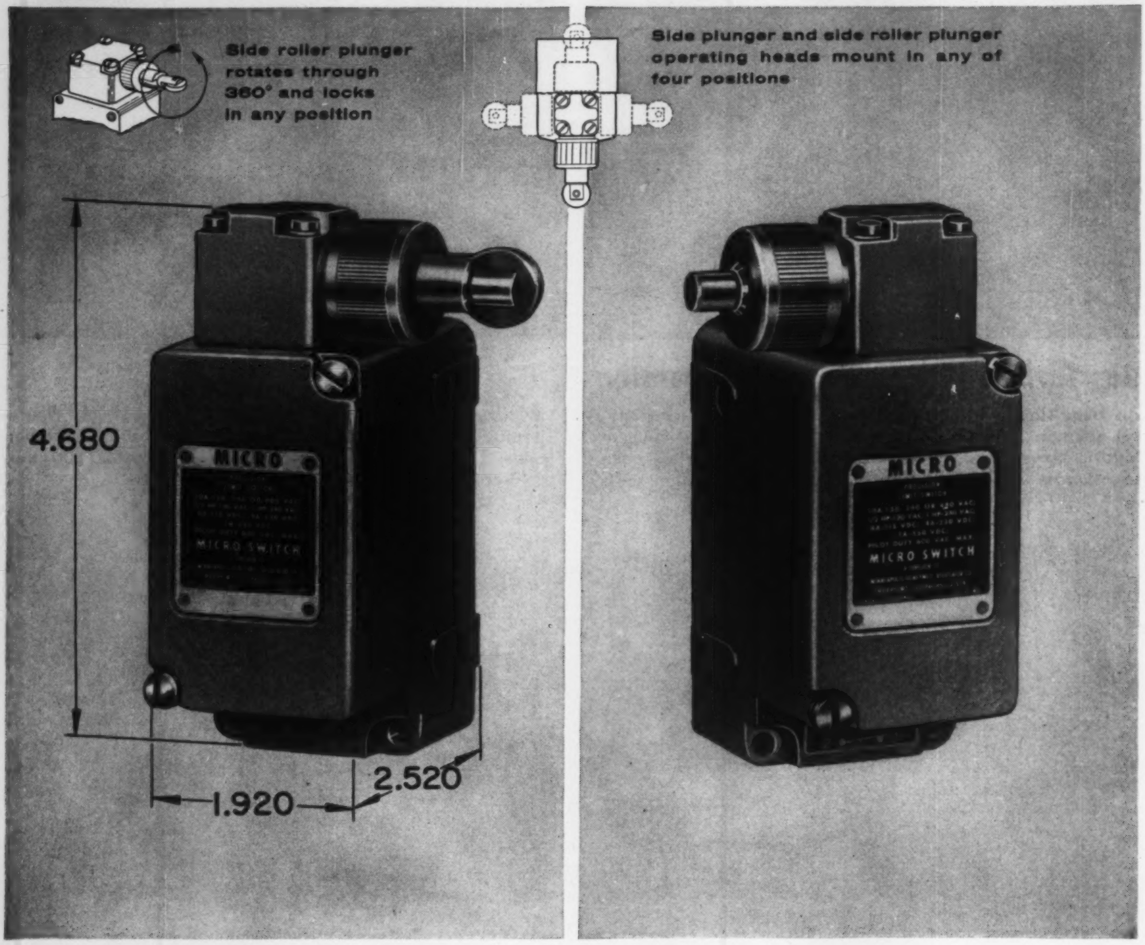
Breakthroughs Were Scheduled In Polaris Missile Program

ATLANTA, GA.—Reversing previous patterns of designing a missile envelope around off-the-shelf powerplants, guidance systems, and other components, Lockheed Aircraft Corp. started with the end product and worked back in developing the Polaris missile. "And this is the biggest single factor in the present success of the program," according to Lockheed engineer S. W. Buriss, Polaris missile system manager.

He said most previous weapon systems have been obsolete from the start because standard components were used to give 90 per cent assurance of meeting performance and schedule goals.

In the case of Polaris, however, dimensions had to be frozen early in the game—to permit installation of the right number of missiles, in the right size submarine, at the right time. After the missile's size, weight, and shape were specified, and after characteristics of the necessary subsystems were determined, Buriss says Lockheed then decided what state-of-the-art advances were needed, and literally scheduled these advances. Polaris development has been ahead of schedule ever since, despite this initial handicap.

HONEYWELL **MICRO SWITCH Precision Switches**


Side roller plunger rotates through 360° and locks in any position

Side plunger and side roller plunger operating heads mount in any of four positions

New 203LS1 "Plug-in Limit" switch with side roller plunger actuator

New 204LS1 "Plug-in Limit" switch with side plunger actuator

Two new switches added to sealed "Plug-in Limit" line

The addition of these two new switches greatly increases the usefulness of the pace-setting "Plug-in Limit" line. Like the other "200LS" switches, they are rugged, reliable, compact, and completely sealed against oil, water, dirt and dust.

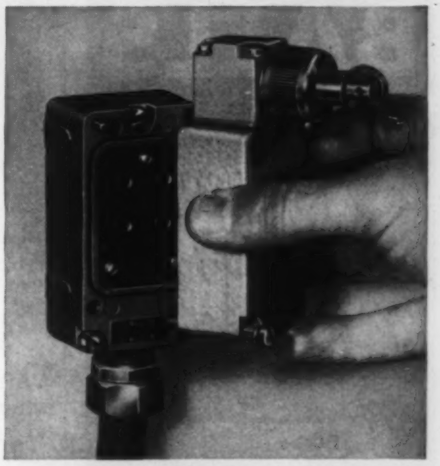
These new units also share the quick-change plug-in feature, as illustrated and described at upper right, which virtually eliminates downtime and gives unmatched versatility of machine control.

"Plug-in Limit" switches are two-circuit double-throw. Electrical rating is 10 amps., 120, 240, 480 vac; ½ H.P. 120 vac; 1 H.P. 240 vac; 0.8 amp. 115 vdc; 0.4 amp. 230 vdc; 0.1 amp. 550 vdc. Pilot duty rating is 600 vac max. They meet NEMA Industrial Control Standards.

See the Yellow Pages for nearby distributors and MICRO SWITCH branch offices. For details on 58 different limit switches, send for Catalog 84.

MICRO SWITCH Precision Switches

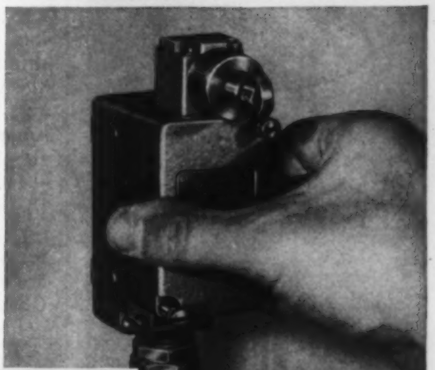
PULL OUT



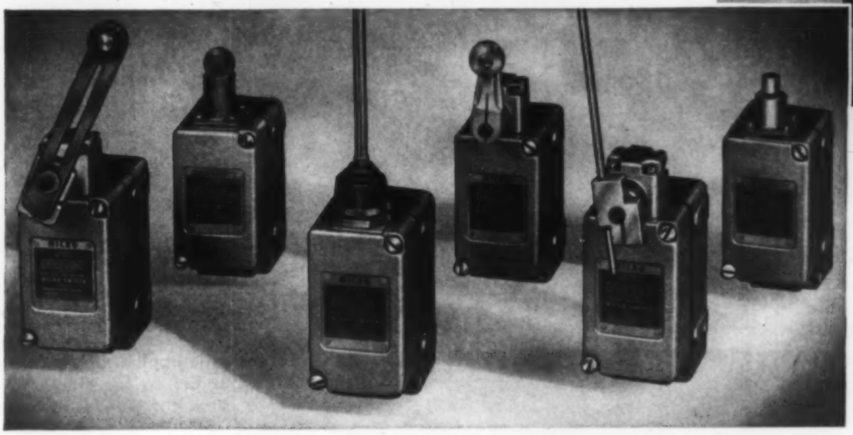
You can replace or interchange a "Plug-in Limit" switch in 20 seconds

A "Plug-in Limit" switch plugs into the terminal enclosure like a radio tube and is secured by two No. 10 screws. Together, the two parts form a sealed assembly. All eight switches in this series use the same terminal enclosure—18PA1. A switch can be replaced or control arrangement changed in as little as 20 seconds.

PLUG IN



With the two new switches, the "200LS" series is now available in 8 different types to meet an even wider range of industry needs. The six others are, left to right: 201LS3 adjustable arm rotary actuator; 205LS1, roller plunger actuator; 208LS1, coil spring actuator; 201LS1 roller arm actuator; 201LS10, rod actuator; 202LS1 push plunger actuator.



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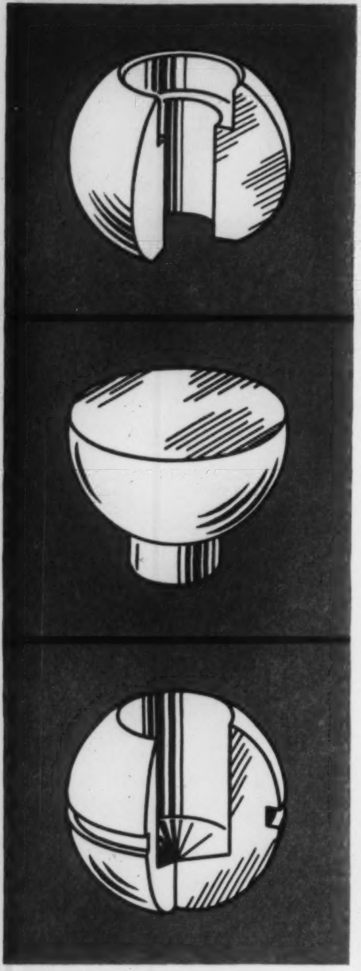
A division of Honeywell
In Canada: Honeywell Controls Limited, Toronto 17, Ontario

Honeywell
MICRO SWITCH Precision Switches

Circle 418 on Page 19



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Write for quotation and descriptive literature.

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INDUSTRIAL TECTONICS, Inc.
MANUFACTURERS OF PRECISION BALLS AND BEARINGS
3691 Jackson Road, Ann Arbor, Michigan

Circle 419 on Page 19

Flexible explosive sheet bends and cuts easily. Any cutting arrangement that might conceivably cause a spark is avoided.

Cut-Rate Shearing

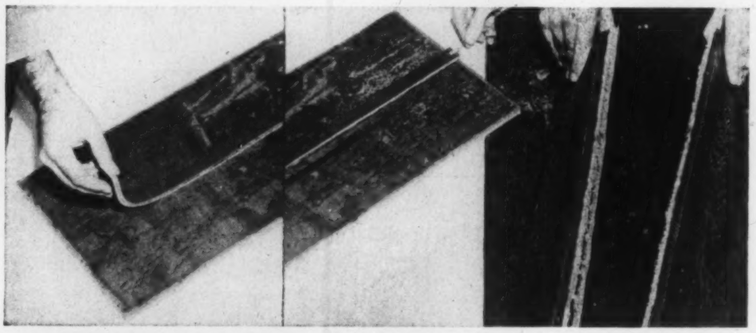
Here's How To Rough Out Heavy Plate with Knife, Glue, and a Plastic Explosive

WITH the development of explosive shearing, designers need not hesitate to specify configurations that demand shearing heavy plate. Now it can be done in small job lots without expensive equipment through the use of plastic-sheet explosive developed by DuPont. Rough cuts of many simple shapes, like square or circular ports, as well as simple cutoffs can be made.

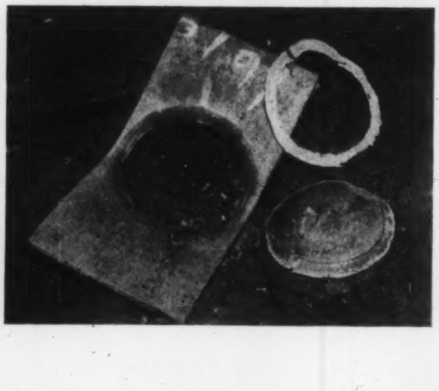
Half-inch stock may need only the application of a 1-in. strip of the explosive with a small detonating cap attached. Thicker sections are cut better with a shaped charge. Charges can be cut to the shape desired with a linoleum knife backed by a nonsparking surface.

After shaping the charge, the user glues it to the surface to be cut. He attaches a cap, stands back and blasts. For clean cuts, a good backing surface is essential. The part is either laid flat on hard ground, or immersed in water (the charge is not affected by water).

The plastic explosive is pretty safe; it has been tested successfully by firing 30-cal bullets into it, and by dropping it onto a wood fire. Nevertheless operators should be especially trained and should have a thorough knowledge of state and local regulations governing the use of explosives.

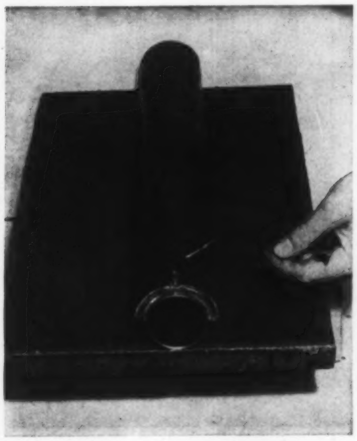


Explosive is applied at the rate of 8 gm per sq in. of metal. For a clean cut without distortion, care is taken to glue the explosive down evenly without bubbles. A small dynamite cap, center, detonates it.



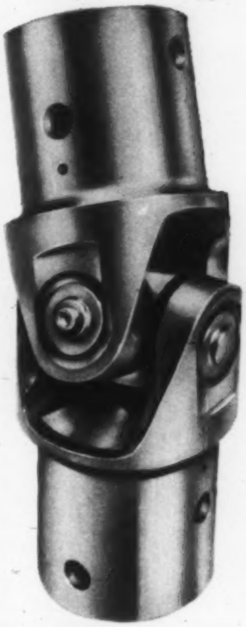
Doughnut shaped charge cuts a clean circle out of ½-in. steel.

Recommended method for cutting the explosive sheet is to use linoleum knife on a nonsparking board.



To cut a 1-in. plate, charge is shaped over 2-in. copper tubing, the charge covering the upper half of the tube. Resultant forces are in a plane bisecting the arc of explosive. Hot bits of tubing add to the cutting action.

~~"Looseness" is typical
of universal joints
incorporating needle bearings.~~



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HIGH CAPACITY ANTI-FRICTION

APEX UNIVERSAL JOINT

Apex anti-friction universal joints are available with lubricant-retaining covers, an exclusive Apex development.

The Apex anti-friction universal joint eliminates the "looseness" expected in ordinary universal joints incorporating needle bearings. This completely different high capacity joint has normal backlash limits ranging below .08°, can be furnished with 0° backlash.

Thoroughly tested and proved, Apex anti-friction universal joints make possible critical systems with little or no initial backlash, and maintain a lash-free system for extended periods.

For complete information on the function of these new Apex universal joints in solving the most difficult drive-line design problems, write, on your company letterhead please; engineering service is available.

THE
APEX
MACHINE & TOOL CO.
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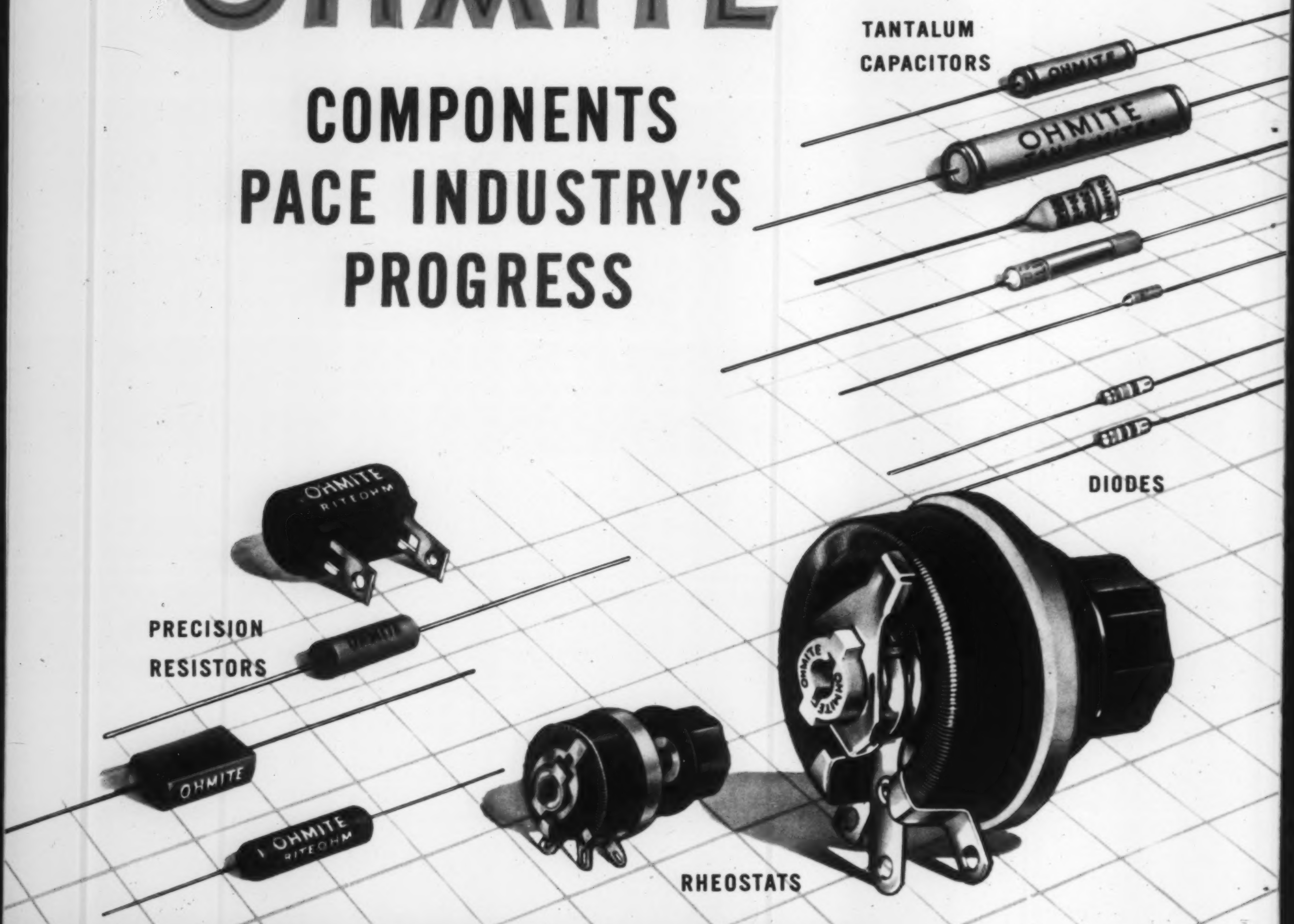
Circle 421 on Page 19→

OHMITE®

COMPONENTS PACE INDUSTRY'S PROGRESS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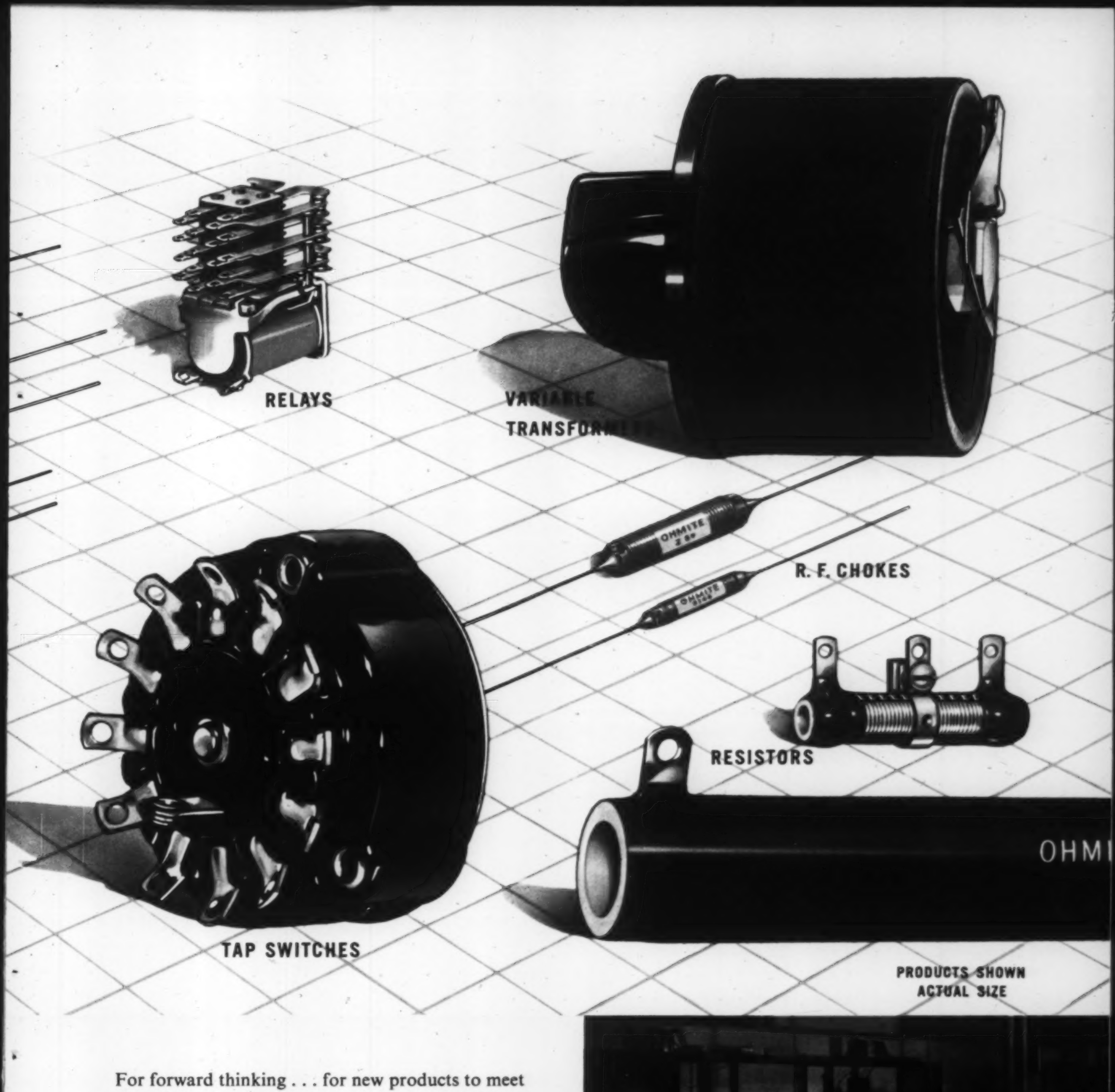
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PRODUCTS SHOWN
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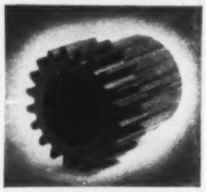
For forward thinking . . . for new products to meet the needs of tomorrow . . . you can depend on Ohmite. Ohmite maintains a continuous program of research and development to explore new product ideas and to improve present products and processes. Furthermore, Ohmite's superb laboratory facilities permit in-plant testing of its products to meet rigid military specifications.

This unceasing research activity has kept Ohmite components truly "pacing the progress of industry."

Ohmite has complete laboratory facilities where difficult customer application problems are studied.



No one wants to hear the gears turning!

A TAYLOR laminated plastic gear is noiseless, acts as a safety valve in a gear train

You can solve two problems with a single gear made from TAYLOR laminated plastic silent gear stock. Noise of meshing gears can be eliminated. Damage due to destructive overloads can be localized to protect the rest of the gear train and equipment. And the laminated plastic gear will outwear metal under normal operating conditions. Look into the physical and mechanical properties of TAYLOR laminated plastic silent gear stock. It is adaptable to a wide variety of applications. Write TAYLOR FIBRE CO., Norristown 47, Pa.

Taylor

LAMINATED PLASTICS VULCANIZED FIBRE

Radar Screen Simulates Three-Dimensional View

CLIFTON, N. J. — Azimuth, target range, and target elevation are interpreted simultaneously in a new TV type display. Azimuth and elevation are plotted in conventional manner as horizontal and vertical coordinates on the face of the tube. Range is indicated by intensity which increases in discrete intervals as the target approaches the receiver. A grid at the bottom of the tube interprets mid-air position.

Information from the radar is stored in two electrostatic storage tubes which alternately store, readout, and erase on successive antennae scans. Readout is done by TV scan at standard RETMA rates. Allen B. DuMont Laboratories developed the Radar Data Scan Convertor under sub-contract from Bell Helicopter Corp. as part of the Army-Navy Instrument Program.

Display Indicates Cam Flaws

Electrified dial indicators actuate switching contacts to flash information of the surface condition of cams on a light panel. Gage developed by Federal Products Corp., Providence, R. I., checks up to seven different cams in a stack simultaneously. Pantographs connect reference contacts, which ride a master cam fixed to the shaft, with gage contacts. Variation between master and sample cams moves the spindle of an indicator to change the light pattern on the panel.

Circle 422 on Page 19

Metals Matters

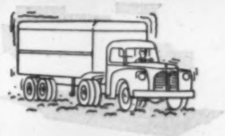
More effective armor . . .
may result from a new method of studying shock wave patterns in metals created by impacts and explosions. Developed by U. S. Army Engineer Research and Development Laboratories, the new system is simple and dependable: An explosion is set off at the end of a metal bar to which a strain gage has been attached. Signals from the strain gage are transmitted to an oscilloscope which, in turn, is monitored by a Polaroid camera. Curve of the pips on the oscilloscope face indicates propagation speed of the shock waves, shape of the waves, maximum strain, and duration of strain.

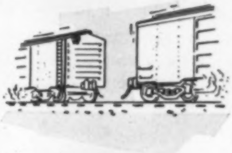
No-so-inert titanium . . .
has been surprised in the act of burning by scientists at Stanford Research Institute. While it has been known that finely divided titanium would oxidize, as will most other metals in a similar state, solid pieces were expected to remain stable—protected by a thin adherent coating of oxide. This was the assumption until Oak Ridge National Laboratory recorded the repeated destruction of a titanium valve used in a test loop containing a hot pressurized solution and oxygen. SRI scientists discovered that titanium ignites when a fresh, uncoated surface of the metal is exposed to oxygen—as when a solid piece of the metal is ruptured. They also discovered that once oxidation starts, it will continue in an atmosphere with much lower oxygen content than that needed for initiation.

Fatigue strength is lowered . . .
in high strength steels by austenite retained in the matrix, according to experiments conducted at National Bureau of Standards. Results of the experiments also showed that fatigue stressing transforms retained austenite to untempered martensite, which probably causes the undesirable effect. Experiments were conducted on four different low-alloy steels with carbon content ranging from 0.44 to 1.06 per cent.

Water spots and stains . . .
caused by hot-water rinses—after plating, pickling, or other chemical processing—are eliminated with a new liquid additive developed by Enthone Inc., New Haven, Conn. Called Entek 45, the additive causes rinse water to shed rapidly from metal surfaces, which results in fast, spot-free drying. It also leaves a strongly adsorbed, invisible film on the metal surface to prevent tarnishing and corrosion over long periods.

Vibration-proof joints
now made quickly, economically with new
TOWNSEND VERSA-LOCKBOLT





With the new Townsend Versa-Lockbolt* you get the same high tensile values as with the standard type but they cost less and are easier to install.

Wider grip ranges in a given size are provided by additional locking grooves. Other design changes make it feasible to use them in relatively oversized holes. Inspection time is reduced since hole size is less critical.

These features make for flexibility of design—make calculations simpler and more accurate.

Versa-Lockbolt installation is fast and guns provide uniform draw down or clinch—locking the collar with up to five tons of pressure. The new collar with its flanged integral washer makes it especially suitable for fastening even light gage materials.

For more information on how to get new vibration-proof fastening economy, write Townsend Company, P.O. Box 237-E, New Brighton, Pa.

*Licensed under Huck patents RE 22,792; 2,114,493; 2,527,307 2,531,048; 2,531,049 and 2,754,703

The Fastening Authority
Townsend
COMPANY • ESTABLISHED 1816
NEW BRIGHTON, PENNSYLVANIA
Sales Offices in Principal Cities
Cherry Rivet Division • Santa Ana, California

Circle 423 on Page 19

VITREOUS-ENAMELED
RESISTORS

SPECIAL RESISTORS FOR YOUR DESIGNS

Stab-on terminals and a square hole for positive-lock mounting . . . typical of the special resistors available from General Electric. No matter what your needs, G-E resistors can be designed to your *exact* requirements. For your resistor catalog, follow reader service instructions below. General Electric Co., Roanoke, Virginia. 784-16

Progress Is Our Most Important Product

GENERAL ELECTRIC

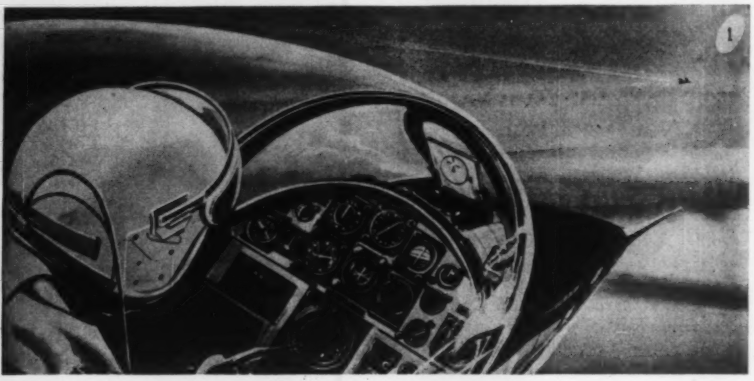
Circle 424 on Page 19

Optical Sight Aims Armament of World's Fastest Fighter

JOHNSON CITY, N. Y.—The old optical gunsight, in slightly polished form, is back in service in the world's hottest production aircraft. Details of the optical-radar armament-control system for Lockheed's F-104 were recently disclosed by its designer, General Electric Co.

Known as the AN/ASG-14, the new system uses radar to detect, locate, and measure range to the target. The optical sight serves as an aiming reference for the plane. When radar locks on the target, the optical sight "computes" and displays the required lead angle. Essential data are range to the target (measured by the radar), speed and altitude (obtained from the aircraft instrumentation), and angular motion (from the sight's gyroscope).

The aiming reference is a pro-



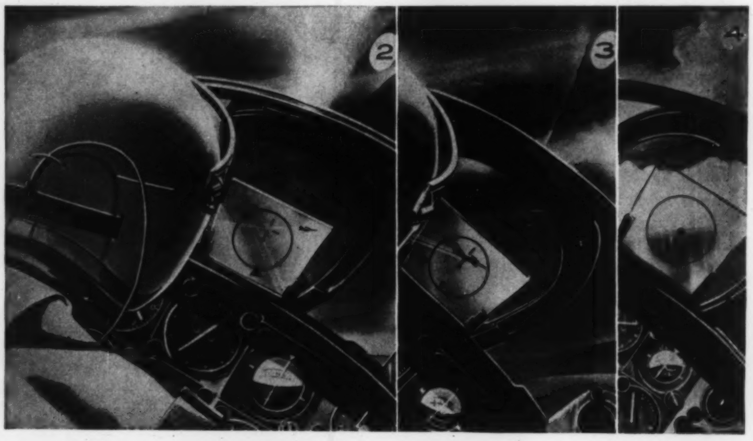
Sequence of a typical target interception:

1. Pilot scans for target which has been previously detected by radar. Missile-aiming reference (crosshair above dot) is shown on combining glass. Range "bug," appears at three o'clock on circle, notifying pilot that his radar is locked-on target at a range beyond firing distance.

2. Pilot maneuvers plane to align target with center of crosshair on combining glass. Range bug meanwhile moves clockwise around circle telling pilot he has reached the maximum effective firing range.

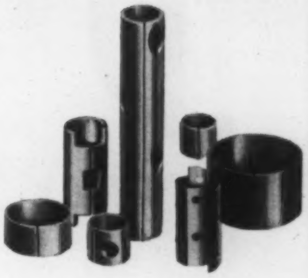
3. Pilot aligns target with crosshair. Range bug has circled clockwise to between 6 and 9 o'clock, indicating the plane is within effective firing range. Firing symbol "F" also appears on combining glass meaning that plane is nearing minimum effective range. Pilot fires his missile.

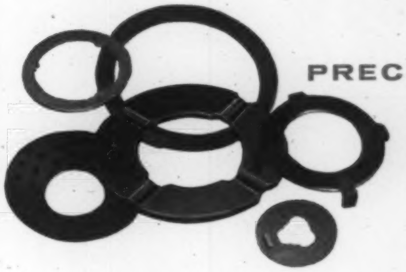
4. If pilot does not break off his attack immediately after firing, crosshair disappears and he will hear a buzzing sound in his earphones—a warning that he must maneuver plane to escape collision with pieces of the target.



ROLLED SPLIT SPACER TUBES

Save money, time, materials! Substitute these economical spacer tubes for costly parts machined from pipe or tube. Made of steel, aluminum or stainless to your exact dimensions. Furnished plain or plated.



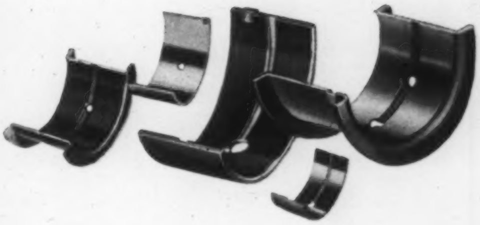


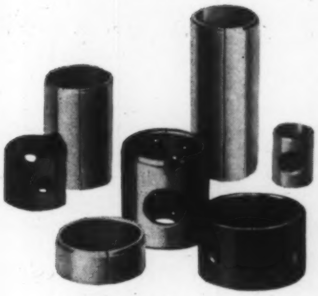
PRECISION THRUST WASHERS

Solid bronze, or steel with bronze on one or both faces. Cold-rolled for extra hardness. Flat, spherical or special shapes. Grooves, holes, nibs, lugs, scallops.

SLEEVE BEARINGS

Tin- or lead-base babbitt, copper alloys, aluminum alloy. These alloys, applied to steel backs, meet 95% of today's engine bearing requirements.





PLAIN and BIMETAL BUSHINGS

Plain: Solid bronze, steel or aluminum. *Bimetal:* Steel lined with bronze, babbitt, copper or aluminum alloy. With oil holes, grooves, slots, notches as required in your application. Straight, lock or special seams.

Consult our Engineering Department for design information, or send for literature.

FEDERAL Mogul

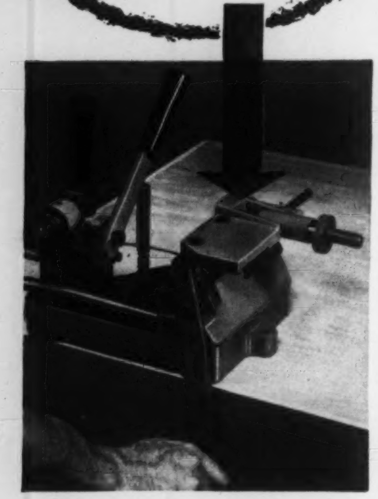
SINCE 1899

FEDERAL-MOGUL DIVISION

FEDERAL-MOGUL-BOWER BEARINGS, INC., 11045 SHOEMAKER, DETROIT 13, MICHIGAN

RESEARCH • DESIGN • METALLURGY • PRECISION MANUFACTURING

make Springs in Seconds!



Save Costly Special Orders With the NEW

DI-ACRO* Spring Winder

This unique machine eliminates costly special spring orders, saves valuable waiting time. Winds compression and extension springs to 1½" O.D. Handles round, flat and rectangular wire to ⅛" dimension. Note exclusive features in the hand operated Di-Acro Spring Winder which assure accurate tension and fast operation without special experience or skill.

new **TENSION CONTROL**—Simply adjust to desired tension—the control keeps it uniform, for winding one spring or hundreds, and releases when each spring is wound.

new **WIRE CUT-OFF**—After spring is wound, release tension and use cut-off lever to quickly cut end of spring to desired length.

new **CAM LOCK**—Simply feed wire under cam, turn handle and wire is securely locked to arbor while spring is wound. No threading required.

FREE-SAMPLE SPRINGS

Send us your spring forming problems — samples or dimension sketches—together with sufficient test material, and let us wind some sample springs for you free of charge. No obligation.

See Di-Acro machines in operation Booth 615 Design Engineering Show Philadelphia, Pa. May 25-28

*pronounced Die-ack-ro

di-acro PRECISION METALWORKING MACHINES

O'NEIL-IRWIN MFG. CO.
416 8th Ave.
Lake City, Minn.

Circle 426 on Page 19

jected light image in the form of a circle with a dot in the middle. The light image is collimated so as to be in focus to the pilot's eyes regardless of the target range and to eliminate parallax from head movement. Brightness and illumination are controlled to assure image visibility against bright backgrounds.

The angular position of the image relative to the zero lead or dead-ahead position is set by a movable mirror controlled by a linkage from the lead-angle computing gyro.

The pilot knows when he is within effective range by watching for a range "bug" or arrowhead, which appears at three o'clock on the combining glass. As the pilot approaches his target the arrowhead moves clockwise around the perimeter of the circle until it reaches nine o'clock.

Meetings

AND EXPOSITIONS

April 23-24—
American Society of Mechanical Engineers-Society for the Advancement of Management. Management Conference to be held at the Statler-Hilton Hotel, New York. Additional information can be obtained from ASME headquarters, 29 W. 39th St., New York 18, N. Y.

April 26-30—
National Screw Machine Products Association. 26th Annual Meeting to be held at the Hotel Roosevelt, New York. Additional information can be obtained from NSMPA headquarters, 2860 E. 130th St., Cleveland 20, Ohio.

April 28-May 3—
Consulting Engineers Council. Third Annual General Meeting to be held at the Biltmore Hotel, New York. Further information is available from council headquarters, 326 Reisch Bldg., Springfield, Ill.

April 29-May 1—
American Society of Mechanical Engineers. Metals Engineering Div. Conference to be held in Albany, N. Y. Further information is available from ASME Meetings Dept., 29 W. 39th St., New York 18, N. Y.

May 11-13—
Joint Automation Conference, sponsored by American Society of Mechanical Engineers, American Institute of Electrical Engineers and Institute of Radio Engineers, to be held at the Pick-Congress Hotel, Chicago. Further information can be obtained from F. D. Snyder, Westinghouse Electric Corp., 40 Wall St., New York 5, N. Y.

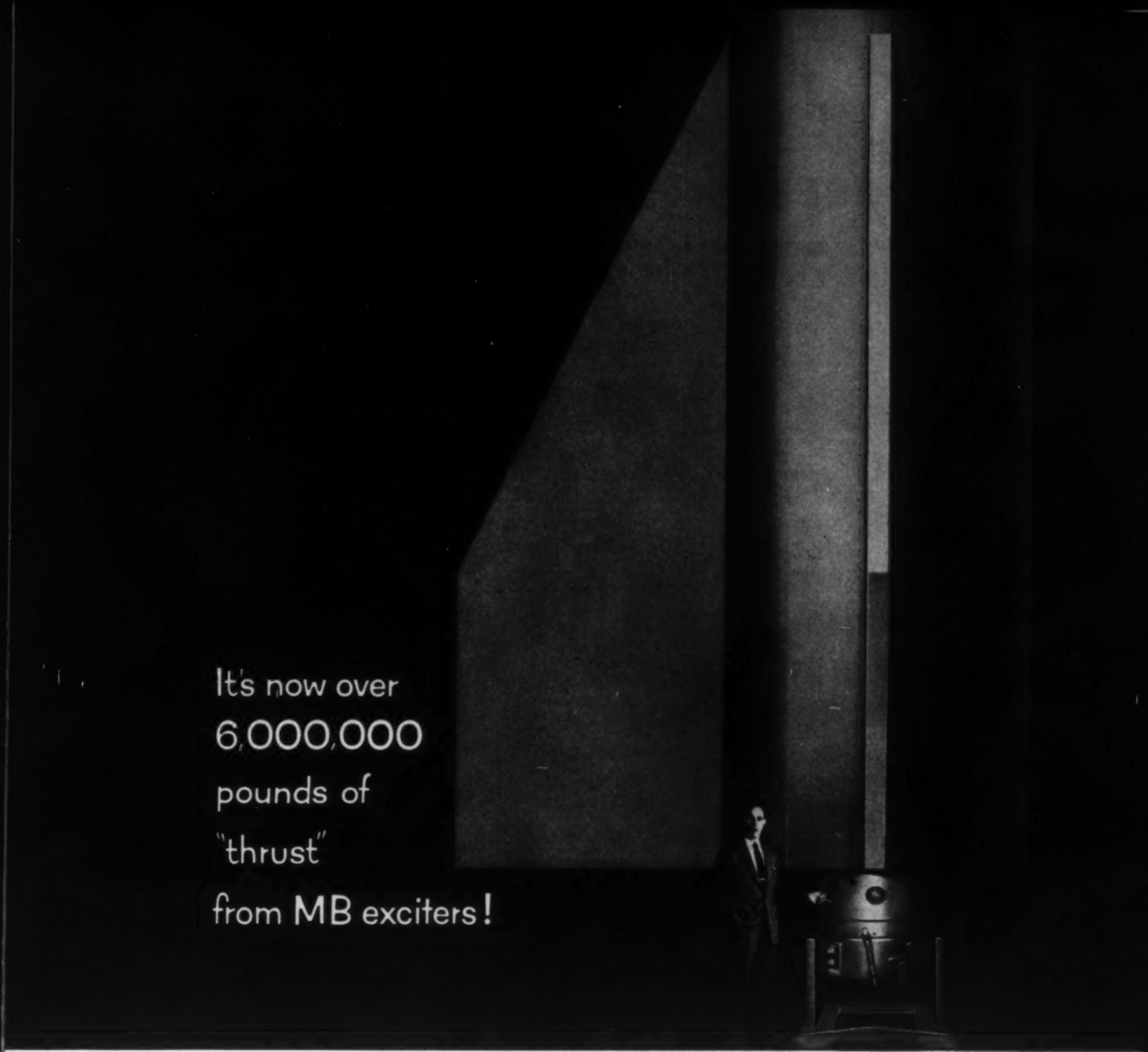
May 12-14—
American Society of Mechanical Engineers. Production Engineering Div. Conference to be held at the Statler-Hilton Hotel, Detroit. Additional information is available from society headquarters, 29 W. 39th St., New York 18, N. Y.

May 15-18—
National Fluid Power Association. Spring Meeting to be held at the Grove Park Inn, Asheville, N. C. Additional information is available from NFPA headquarters, 1618 Orrington Ave., Evanston, Ill.

May 18-20—
Instrument Society of America. Fifth Annual Symposium on Instrumental Methods of Analysis to be held at the Shamrock-Hilton Hotel, Houston, Tex. Further information can be obtained from ISA, 313 Sixth Ave., Pittsburgh 22, Pa.

May 20-22—
Society for Experimental Stress Analysis. Spring Meeting to be held at the Sheraton Park Hotel, Washington, D. C. Additional information is available from R. O. Belsheim, 2475 Virginia Ave. N.W., Apt. 514, Washington 7, D. C.

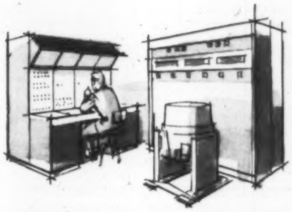
May 25-28—
Design Engineering Show and Conference to be held at Convention Hall, Philadelphia. Conference is sponsored by the Machine Design Div. of ASME. Further information can be obtained from Clapp & Poliak Inc., 341 Madison Ave., New York 17, N. Y.



Six million pounds at least — that's the cumulative force from *thousands* of MB shakers in the field. Accompanying MB power amplifier output has rocketed beyond *two million watts.*

MB output is actually the measure not only of vibration testing's progress in 10 years, but also of its great *importance* to reliability. In fact, virtually the entire missile vibration testing program rests on MB exciters.

In producing the widest scope of complete systems for simple and complex motion testing, MB has accumulated unmatched experience in the techniques of testing. It is applied with engineering imagination, administered through the largest field force of vibration specialists. It is ready to help you.



Pioneer and leader
in the field of vibration

MB MANUFACTURING COMPANY

A DIVISION OF TEXTRON INC., 1056 State Street, New Haven 11, Conn.

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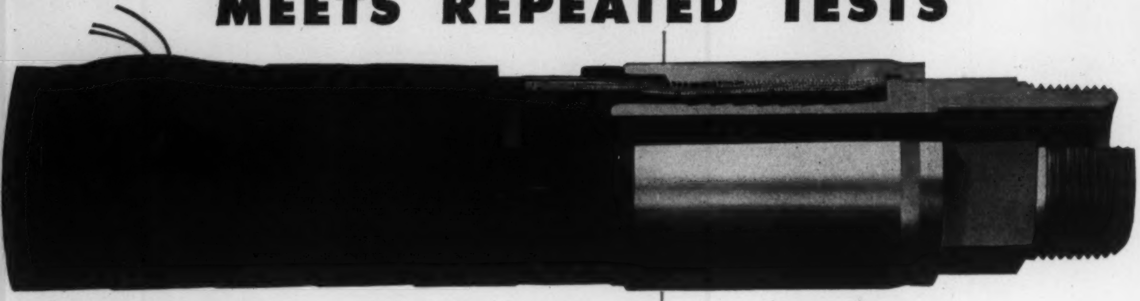
Eastman APPLICATION MEETS REPEATED TESTS



Tests prove that Eastman couplings applied to super high pressure 4-ply spiral wire hose assure successful assemblies. Couplings hold well above minimum burst pressure.

PERMANENTLY ATTACHED COUPLINGS PROVIDE BOND STRONGER THAN HOSE ITSELF!

Increasing demand for greater power brought about the use of higher pressures in hydraulic systems. This not only calls for greater hose strength, but far more critical engineering in coupling design and application.

EASTMAN is contributing toward the development of the trend toward higher pressures—not only in the design and application of coupling to hose—but in the more exhaustive tests required to assure adequate safety under high pressure operations.

The actual photo above is typical of many tests in Eastman laboratories proving that the hose did not fail at the coupling—demonstrating that the coupling was designed and applied to form *a bond which was stronger than the hose itself*.

If you have an application requiring higher pressures, let our engineering department demonstrate the superiority and economy of Eastman applications, and quote on complete Hydraulic Hose Assemblies.

Eastman
first-in-the-field

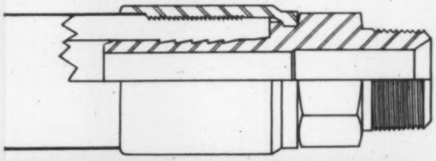
MANUFACTURING COMPANY
Dept. MD-4
MANITOWOC, WISCONSIN

WRITE today for your copies —

Technical Bulletin 100—Medium Pressure Hose and Tube Assemblies, Couplings and Fittings for One Wire Braid Hose.

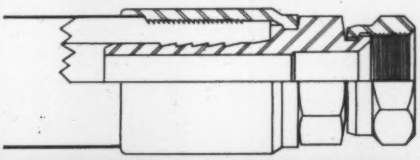
Technical Bulletin 200—High Pressure Hose and Tube Assemblies, Couplings and Fittings for Multiple Wire Braid Hose.

MALE NPTF



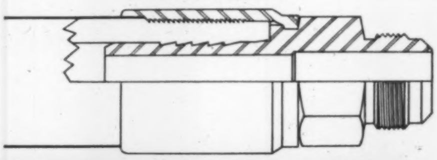
Catalog No.	Hose I.D.	Hose O.D.	Coupling I.D.	Min. Burst Pressure (P.S.I.)	Max. Wkg. Pressure (P.S.I.)
	(inches)				
8412-12M	¾	1 7/16	19/32	20,000	5,000
8416-16M	1	1 ¾	25/32	16,000	4,000
8420-20M	1 ¼	2	1 5/64	12,000	3,000
8424-24M	1 ½	2 ¼	1 21/64	10,000	2,500

SWIVEL FEMALE JIC-37°



Catalog No.	Hose I.D.	Hose O.D.	Coupling I.D.	Min. Burst Pressure (P.S.I.)	Max. Wkg. Pressure (P.S.I.)
	(inches)				
8412-12FH	¾	1 7/16	19/32	20,000	5,000
8416-16FH	1	1 ¾	25/32	16,000	4,000
8420-20FH	1 ¼	2	1 5/64	12,000	3,000
8424-24FH	1 ½	2 ¼	1 21/64	10,000	2,500

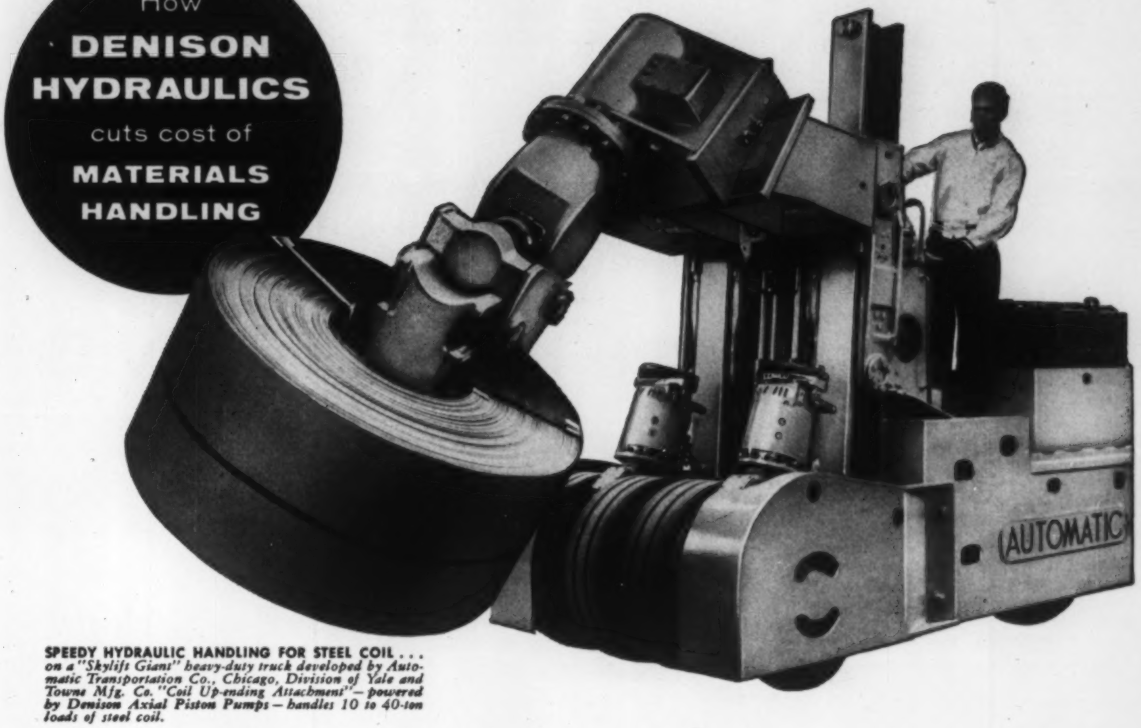
MALE JIC-37°



Catalog No.	Hose I.D.	Hose O.D.	Coupling I.D.	Min. Burst Pressure (P.S.I.)	Max. Wkg. Pressure (P.S.I.)
	(inches)				
8412-12MH	¾	1 7/16	19/32	20,000	5,000
8416-16MH	1	1 ¾	25/32	16,000	4,000
8420-20MH	1 ¼	2	1 5/64	12,000	3,000
8424-24MH	1 ½	2 ¼	1 21/64	10,000	2,500

Circle 428 on Page 19

How
DENISON HYDRAULICS
cuts cost of
MATERIALS HANDLING



SPEEDY HYDRAULIC HANDLING FOR STEEL COIL . . . *on a "Skylift Giant" heavy-duty truck developed by Automatic Transportation Co., Chicago, Division of Yale and Towne Mfg. Co. "Coil Up-ending Attachment"—powered by Denison Axial Piston Pumps—handles 10 to 40-ton loads of steel coil.*

AUTOMATIC® trucks handle steel coil like a baby . . . faster, safer with **DENISON** hydraulic power

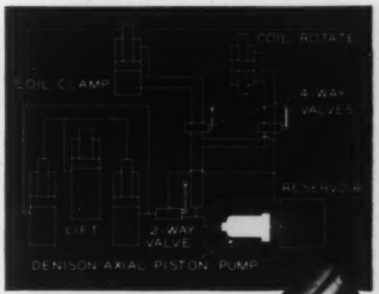
HERE'S the business end of a "Skylift Giant" industrial truck—equipped with a special "Coil Up-ending Attachment". Its jaws easily heft rolls of coiled steel weighing from 10 to 40 tons . . . *with Denison hydraulic power that pays off in smoother, faster, safer handling.*

In leading mills—these heavy-duty trucks speed handling and storage without damaging coils. The Coil Up-ending Attachment is designed to enter the coil's inside diameter with a fixed ram . . . while the outside is gripped by a powerful hydraulic clamp. This clamp-and-ram design prevents "telescoping" of coils during handling.

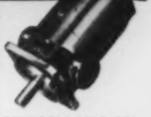
Three hydraulic cylinders—powered by motor-driven Denison 3000 psi Axial Piston Pumps—furnish lifting and clamping power. All three cylinders are connected hydraulically in parallel which results in a telescopic-cylinder action—but has the added advantage of retaining equal force and speed throughout the stroke at constant pressure and delivery.

Result: operator easily controls lowering speed at any level . . . and can inch the load up from extremely slow speed to maximum for which the flow control is set. *Safe, fast, smooth hydraulic control helps keep "Skylift" trucks continuously on the job . . . handling extra payload.*

Here's the kind of job your Denison Hydraulic Specialist can help *you* do *now*. Call him in soon . . . see how Denison hydraulic power can help put *more payload* into *your equipment*. Write us for details.



HYDRAULIC CIRCUIT DIAGRAM *. . . illustrates system for powering "Coil Up-ending Attachment". Denison equipment delivers hydraulic lifting and clamping power.*



DENISON 3000 PSI AXIAL PISTON PUMP

DENISON ENGINEERING DIVISION
American Brake Shoe Co.
1240 Dublin Road • Columbus 16, Ohio

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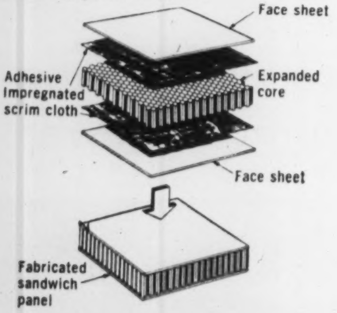
HYDRAULIC PRESSES • PUMPS • MOTORS • CONTROLS

one of a series
DESIGNING WITH
HONEYCOMB

DESIGNERS' CHOICE: Materials for HONEYCOMB SANDWICH STRUCTURES

Honeycomb sandwich structures are composed of thin, high strength facings integrally bonded to light weight core material. The selection of materials to be used in such a structure is of primary importance in arriving at a satisfactory design providing optimum performance.

Figure 1 illustrates the three primary parts of this composite structure.



Facing Selection

Generally the facings in a sandwich structure are selected in order to provide the highest compressive strength-to-weight ratio economically available in the size range under consideration. Examples of facings on successful sandwich applications are carbon steel in thicknesses of .030 to .050 for heavy duty flooring applications; aluminum alloy 7075 T6 in thicknesses of .010 to .093 for flooring and highly stressed panel applications, and porcelain enamel steel in 14 to 24 gauge for exterior curtain wall applications. Other special applications have dictated the use of high temperature reinforced fiber glass-plastic skins, stainless steel skins, cement asbestos board skins and similar materials. In every case, the facing selection must meet the multiple criteria of economy, structural efficiency, and process compatibility.

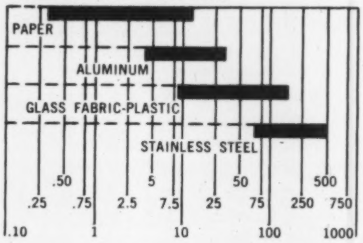
Adhesive Selection

There are now available to designers a number of adhesive systems for attaching honeycomb core materials to high strength facings. Most high strength structural adhesives are based on various combinations of thermosetting resins which provide structural integrity throughout the environmental conditions encountered. For lightly loaded panels subject to less exacting environmental conditions there are a number of adhesives based on thermoplastic or elastomeric resins, some of which permit very economical sandwich fabrication.

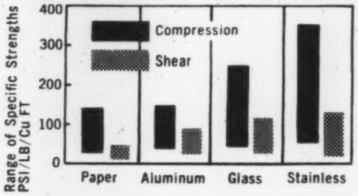
Honeycomb Core Selection

Core materials are selected on the basis of structural performance, environmental requirements, and economy.

APPROXIMATE COST—VARIOUS HONEYCOMB CORE MATERIALS ($ Per Cubic Foot)



It can be seen that the cost of honeycomb core materials varies considerably. It should not be inferred, however, that the performance of a particular core is measured by its cost. Figure 3 indicates the specific strength of the same honeycomb core materials illustrating the differences in load carrying ability.



With proper selection of facing, adhesives and honeycomb core, the designer can achieve optimum structural performance with minimum weight. For example, a beam of steel plate weighing 68.6 lbs. can be replaced by a structural honeycomb sandwich beam of 7.8 lbs. with the same deflection and strength.

The design opportunities for honeycomb sandwich structures are apparent.

Since World War II designers of air and space craft have made ever-increasing use of honeycomb in a great variety of structural and non-structural applications. Honeycomb can be made from almost any material available in continuous web or roll form, e.g., aluminum, glass fabric, cotton, stainless steel, paper, asbestos, titanium. In its cellular configuration, honeycomb is 97% air, 3% material.

Honeycomb has intrinsic qualities of high strength, light weight, high ratio of surface area to volume and other specific properties which depend upon the type of material used. These combinations of properties, which have given honeycomb wide application in air and space craft, offer to designers in industry generally unique opportunities in product design. In the interest of advancing this knowledge of honeycomb, Hexcel, through its research and development staff (the industry's largest), has prepared this informational series. Should you desire additional technical information or copies of others in this series, please complete the information request form on this page. Your request will receive immediate attention.

INFORMATION REQUEST

Send to Hexcel Products Inc. Dept. D-1
2332 Fourth Street, Berkeley 10, California.

NAME____________________

TITLE____________________

COMPANY____________________

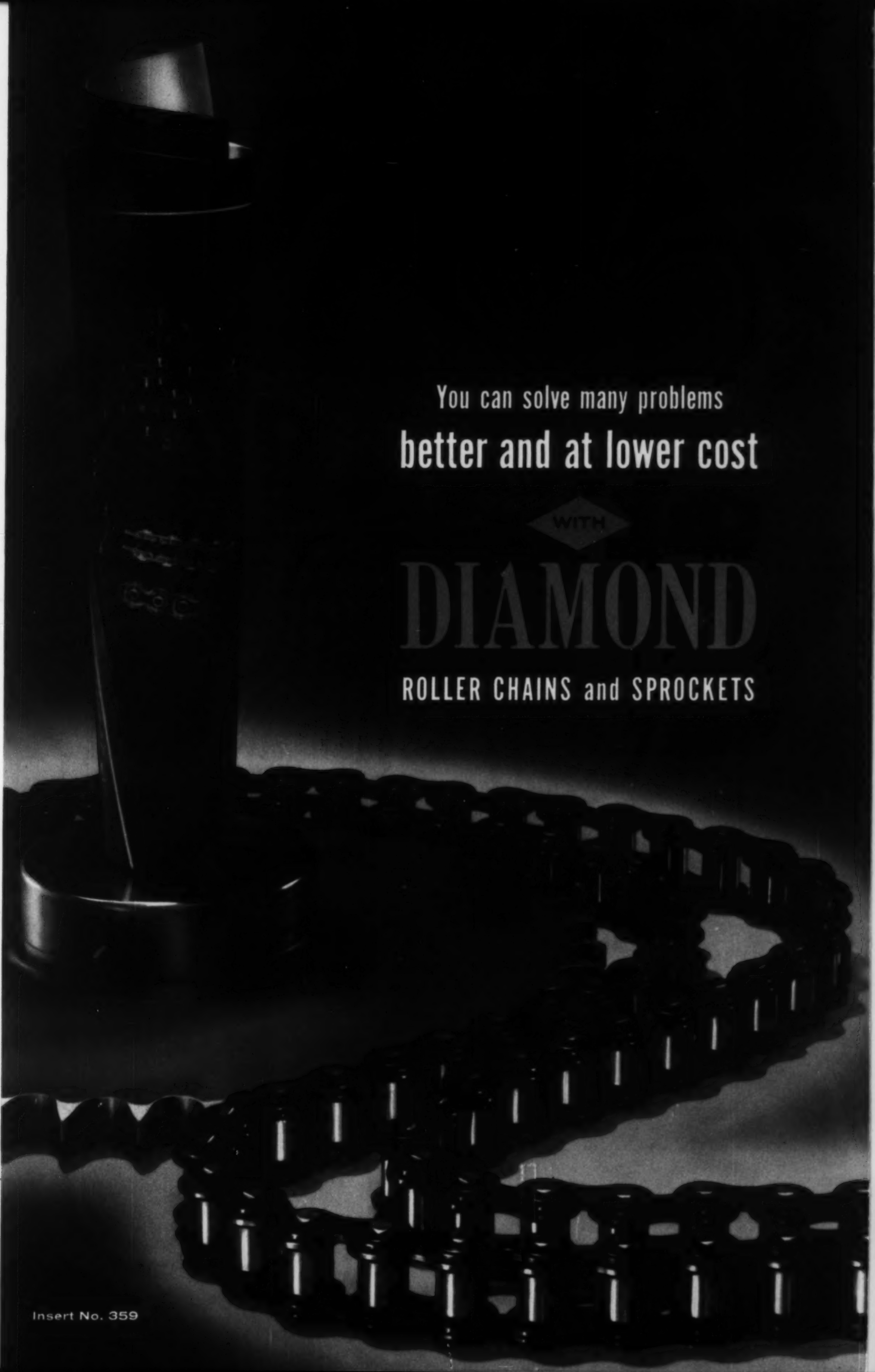
STREET____________________

CITY__________ ZONE____ STATE________

HEXCEL® PRODUCTS INC.
World leader in honeycomb
***Executive offices:** 2332 Fourth St., Berkeley, California*
***Plants:** Oakland and Berkeley, California; Havre de Grace, Maryland*
***Sales offices:** Inglewood, Calif.; Fort Worth, Texas; Long Island City, N. Y.* 5475

Circle 430 on Page 19

Circle 431 on Page 19→


You can solve many problems
better and at lower cost
WITH
DIAMOND
ROLLER CHAINS and SPROCKETS

Insert No. 359

You get ALL THESE DESIGN ADVANTAGES

when you use

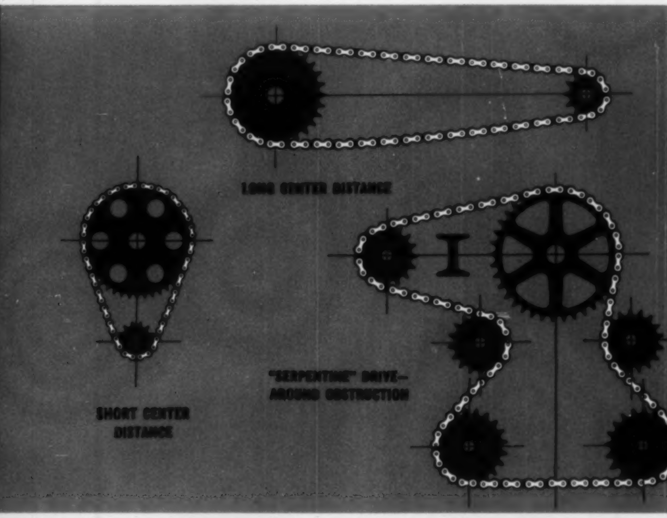
DIAMOND
ROLLER CHAIN

You get *more for your dollar* with DIAMOND Roller Chain than with any other mechanical power transmission medium. Its important design advantages (some of which are described on these pages) . . . plus low first cost, low installation cost and low service cost . . . make DIAMOND Roller Chain a highly *efficient* and *economical* solution to virtually any mechanical power transmission problem.

◆

Adaptability

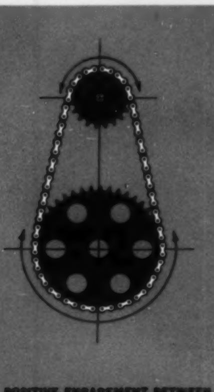
DIAMOND offers maximum adjustability to long or short center distances. Several shafts may be engaged, rotated in either direction at various speeds all from a common drive shaft. Speed ratio changes are made easily by changing sprockets.



◆

Positive Power

Multiple engagement of sprocket teeth with roller links assure a non-slipping drive. Heavy static and radial loads, thrusts or bearing pressures are reduced (due to elimination of high operating tension as with belts or separating forces as with gears). DIAMOND standard roller chains cover a wide range of horsepower and speed combinations (see Table).



POSITIVE ENGAGEMENT BETWEEN ROLLER LINKS AND MANY SPROCKET TEETH

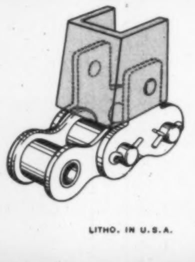
SPEED AND HORSEPOWER CAPACITIES FOR DIAMOND SINGLE AND MULTIPLE STRAND ROLLER CHAINS

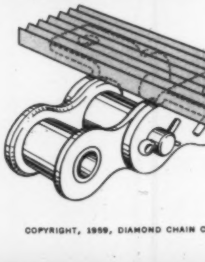
Chain Pitch	Horsepower Up to	At Speeds As High As
¼″	25	8000 R.P.M.
⅜″	120	4500 R.P.M.
½″	220	3370 R.P.M.
⅝″	375	2400 R.P.M.
¾″	480	1800 R.P.M.
1″	950	1160 R.P.M.
1¼″	1440	800 R.P.M.
1½″	1200	650 R.P.M.
1¾″	1540	475 R.P.M.
2″	2300	400 R.P.M.
2½″	2800	280 R.P.M.

For Ratings not shown in table, write to DIAMOND Chain Company.

◆ STANDARD ATTACHMENTS AVAILABLE WITH DIAMOND ROLLER CHAIN

Various types of link plate attachments and extended pins permit the ready adaptation of DIAMOND Roller Chain to a wide range of conveying, timing or synchronized movement problems.





LITHO. IN U.S.A.

COPYRIGHT, 1959, DIAMOND CHAIN C

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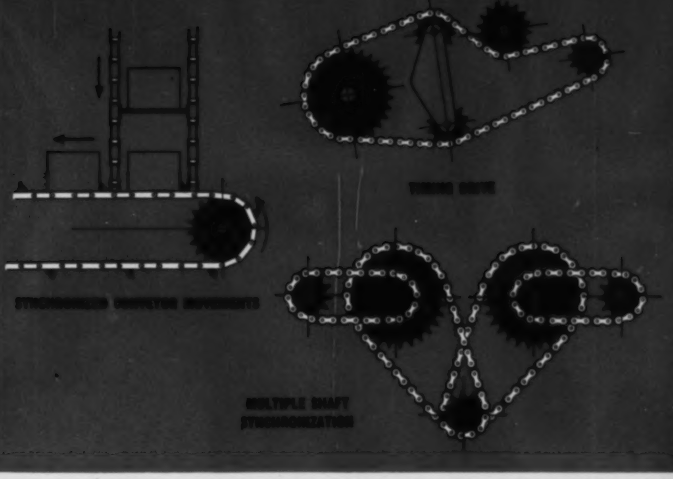
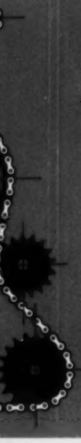
Accuracy

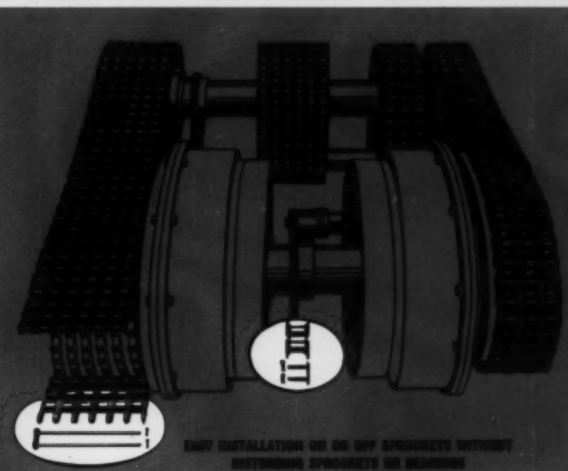
Component parts of DIAMOND Roller Chain are manufactured with uniformity and precision resulting in close total-length chain tolerances. This means that DIAMOND not only operates smoothly and quietly . . . but that two or more chains may be run in parallel or to synchronize multiple shaft movements in one machine.


TIMING DRIVE
SYNCHRONIZED CONVEYOR MOVEMENTS
MULTIPLE SHAFT SYNCHRONIZATION



Convenience

DIAMOND Roller Chain is easily installed. It may be quickly connected or disconnected by means of a connecting link without disturbing sprockets or bearings. Installation does not require precision alignment of sprockets or shafts.


EASY INSTALLATION ON OR OFF SPROCKETS WITHOUT DISTURBING SPROCKETS OR BEARINGS

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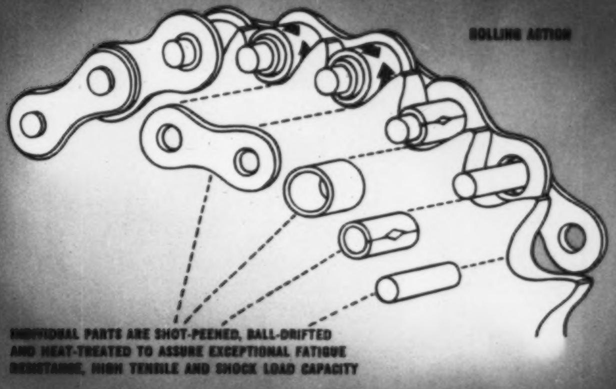
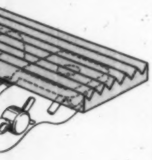
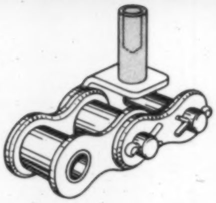
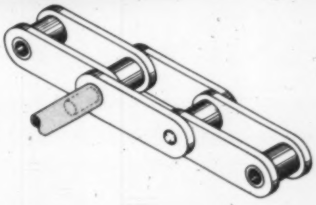
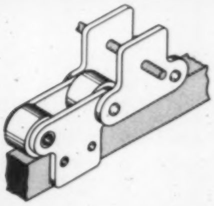
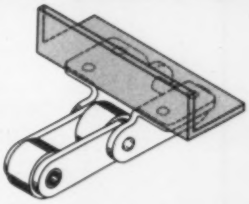
pany.

Durability

Manufacturing refinements and strict quality control are responsible for DIAMOND'S long life and superior performance. Inherent design—positive engagement, large joint bearing areas, wide distribution of load—makes roller chain 98%-99% efficient, the highest rating of all mechanized power transmission media.

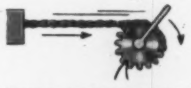

ROLLING ACTION
INDIVIDUAL PARTS ARE SHOT-PEENED, BALL-DRIFTED AND HEAT-TREATED TO ASSURE EXCEPTIONAL FATIGUE RESISTANCE, HIGH TENSILE AND SHOCK LOAD CAPACITY

OND CHAIN CO.

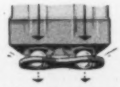
DIAMOND . . . Specialists in Roller Chain Design and Manufacture for more than 68 Years

The quality of DIAMOND Roller Chain . . . both in design and in workmanship . . . is the result of more than 68 years of specialization in solving difficult problems of load, shock, fatigue and abrasion. During this time DIAMOND has contributed many "firsts" to the capabilities of roller chain. It is the *only* roller chain embodying *so many* engineering and manufacturing refinements.



FIRST TO PRE-LOAD PRODUCTION ROLLER CHAIN—Preloading seats pins, bushings and linkplates; takes out initial stretch.

FIRST TO STUDY FATIGUE—First to make design changes in roller chain parts for improved fatigue resistance.



FIRST TO BALL DRIFT—Pitch holes in DIAMOND chain sideplates are ball drifted for greater fatigue resistance.
(DIAMOND patent)

FIRST TO EMPLOY SEAM RELIEF BUSHINGS—Seam relief bushings reduce run-in time and provide better lubrication.
(DIAMOND original patent)

FIRST TO PROPERLY PLACE BUSHINGS—DIAMOND bushing seams are placed away from load-bearing area for improved resistance to wear and fatigue.

FIRST TO SHOT PEEN—DIAMOND chain parts . . . rollers, bushings, linkplates and pins . . . are shot peened for greater fatigue resistance.

Diamond Chain Company Representatives

ATLANTA, GEORGIA
66 FOURTEENTH STREET, N.E.

BATTLE CREEK, MICHIGAN
811 MICHIGAN NATIONAL BANK BUILDING

BOSTON, MASSACHUSETTS
945 GREAT PLAIN AVENUE, ROOM 14
P.O. BOX 347, NEEDHAM 92, MASS.

CHICAGO, ILLINOIS
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17700 LORAIN AVENUE, CLEVELAND 11, OHIO

DALLAS 9, TEXAS
3301 MOCKINGBIRD LANE

HOUSTON 25, TEXAS
5610 BROOKMEADE

LOS ANGELES 21, CALIFORNIA
806 SANTA FE AVENUE

MINNEAPOLIS, MINNESOTA
215 SIXTH STREET, S.E.

NEW YORK 13, NEW YORK
75 VARICK STREET

PHILADELPHIA, PENNSYLVANIA
401 SUBURBAN SQUARE BUILDING, ARDMORE, PENN.

SAN FRANCISCO, CALIFORNIA
606 SANTA CRUZ AVENUE, MENLO PARK, CALIF.

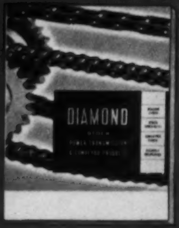
SYRACUSE, NEW YORK
10 HOMER STREET, UNION SPRINGS, N. Y.

TULSA 14, OKLAHOMA
2238 TERWILLEGER BOULEVARD

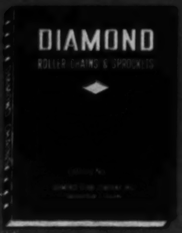
• •

Write for DIAMOND Ready-Reference Catalogs Covering All Roller Chain and Sprocket Needs

These DIAMOND catalogs give full description of the subjects listed, including rating, dimension, conversion tables. Also horsepower ratings, service factors and other engineering data to help you select the right chains and sprockets for your equipment.



STOCK ROLLER CHAIN AND SPROCKET CATALOG



ENGINEERING DATA BOOK FOR DIAMOND ROLLER CHAINS AND SPROCKETS

DIAMOND
DOUBLE PITCH CHAINS & SPROCKETS
DIAMOND CHAIN COMPANY, INC.

DOUBLE PITCH CHAIN AND SPROCKET CATALOG

DIAMOND
COUPLINGS

FLEXIBLE SHAFT COUPLING CATALOG

For complete information or design assistance write direct to:

Diamond Chain Company, Inc.
A Subsidiary of American Steel Foundries
402 KENTUCKY AVENUE
INDIANAPOLIS 7, INDIANA
Offices and Distributors in all Principal Cities

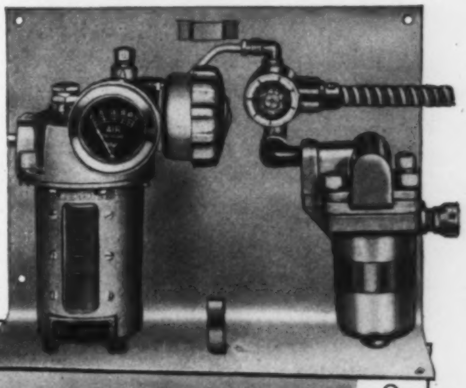
DIAMOND ROLLER CHAINS

How to choose a

LUBRICATION SYSTEM

that provides constant, uniform lubrication

at savings of up to **90%**



use this handy check list:

Will your lubrication system be fully automatic? Oil-Mist starts and stops at the touch of your machine switch.

Will your lubrication system reduce bearing temperatures? The answer is "yes," if it's an Alemite Oil-Mist System. Reduction in fluid oil friction—plus air flow through bearing—greatly cuts bearing heat.

Will you have a continuous system? Oil-Mist constantly feeds a uniform volume of fresh oil to each bearing. No oiling schedules. No feast-or-famine lubrication.

Will the system that you choose cut oil consumption by 90%? With the Alemite Oil-Mist System you can get better bearing lubrication with only 1/10th as much oil as required by other methods.

Will your system extend bearing life? You can definitely count on it, if you choose Oil-Mist. Oil-Mist has extended the service life of many bearings, even under adverse operating conditions, from 10 to 12 times!

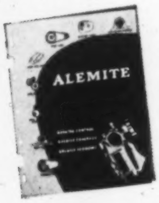
Does it protect against contamination? Satisfied Oil-Mist users say yes. A constant flow of clean, air-oil mixture—Oil-Mist—through bearings keeps out dirt and abrasives. Oil-Mist also eliminates wasteful oil handling and applying.

Lubricates any bearing on any machine in One Of Three Ways:

Oil-Mist for high speed anti-friction type of bearings.

Oil Spray for low speed anti-friction and open and enclosed gears and chains.

Condensed Oil for plain bearings, slides, ways, vees, cams, and rollers.



MAIL COUPON for Oil-Mist demonstration and information

Symbol of SW Excellence

ALEMITE DIVISION STEWART-WARNER CORPORATION

Alemite, Division of Stewart-Warner, Dept. BB-49
1850 Diversey Parkway, Chicago 14, Illinois

☐ Please send me a free copy of your Oil-Mist catalog.

☐ Please have your Alemite Lubrication Representative arrange a no-obligation demonstration.

Name ....

Company ....

Address ....

City .... Zone ..... State ....

OILITE

GEAR GIVES POSITIVE "LIFT" IN POWER HOIST DESIGN

Super Oilite #9 Intermediate Gear (4½" Diameter)

...saves Chisholm-Moore 53¢ per unit

You can be sure this heavy-duty "Lodestar" hoist is a rugged performer capable of handling loads quickly, efficiently . . . the result of CM's 70 years experience in designing and manufacturing hoists for industry!

Only top quality parts qualify. That's why CM engineers specified "Oilite"® for the vital intermediate gear of the train. The Oilite Precision Part provided excellent mechanical properties, close tolerances and fine surface finish. Consequently, gears made of tough, wear-resistant Super Oilite #9 transmit motor power smoothly and quietly . . . have more than enough mechanical strength to assure long, trouble-free life.

Moreover, the Oilite gear is produced as a finished part requiring no machining . . . saving CM *53c on every gear used!* Chrysler-engineered Oilite Precision Parts are obtainable in many metals and alloys to give desired mechanical properties. Savings up to 55% or more are common for parts produced in volume.

Contact your local Oilite Engineer for possible savings on your parts. Look for him in the Yellow Pages under "Bearings—Oilite" or write Dept. S-4.

® Only Chrysler Makes Oilite

MEMBER

SINCE 1929

A CHRYSLER OILITE PRODUCT

the most trusted name in powder metallurgy!

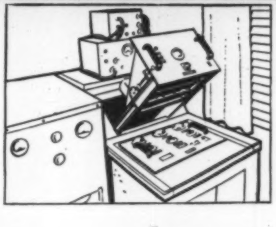
AMPLEX DIVISION

CHRYSLER CORPORATION, DETROIT 31, MICHIGAN

SELF-LUBRICATING BEARINGS • PRECISION PARTS • METAL FILTERS • FRICTION UNITS

Circle 435 on Page 19

GRANT
SLIDES
WITHSTAND
SHOCK



Shock cannot impair the smooth functioning of Grant Slides. The bearing surfaces of Grant Slides are capable of successfully withstanding shock of up to 30 g's. Mobile units, as pictured, must travel over rough terrain. Rugged Grant Slides perform efficiently under such adverse situations because they are fabricated of the highest quality material and are produced by the most experienced personnel. All Grant Slides are precision fitted and tested at every stage of assembly . . . assuring you of dependable operation, wherever the application. *Write for your copy of the Grant Catalogue.*

The nation's first and leading manufacturer of slides

GRANT INDUSTRIAL SLIDES

GRANT PULLEY AND HARDWARE CORPORATION

123 High Street, West Nyack, New York
944 Long Beach Avenue, Los Angeles 21, Cal.

Here's why Dayton Variable Speed Cog-Belts® are being used by more machinery manufacturers

The Dayton Variable Speed Cog-Belt is one of the most successful V-Belt designs resulting from today's demands for higher capacities and greater speed ranges in variable speed drives. You'll find examples everywhere . . .

In the textile industry, where 1% speed variation can mean the difference between profit and loss, hundreds of thousands of spindles are driven by Dayton Variable Speed Cog-Belts.

In the appliance industry . . . automatic washer-dryer combinations powered by Variable Speed Cog-Belts have proved to be a quieter, simpler, cheaper means of shifting from 45 r.p.m., the tumble speed, to 200 r.p.m. during the spin cycle.

In the agricultural industry, where complex machinery requires variations of speed and power, Variable Speed Cog-Belts have long been a standard method of precise adjustment to fit various conditions of load and terrain.

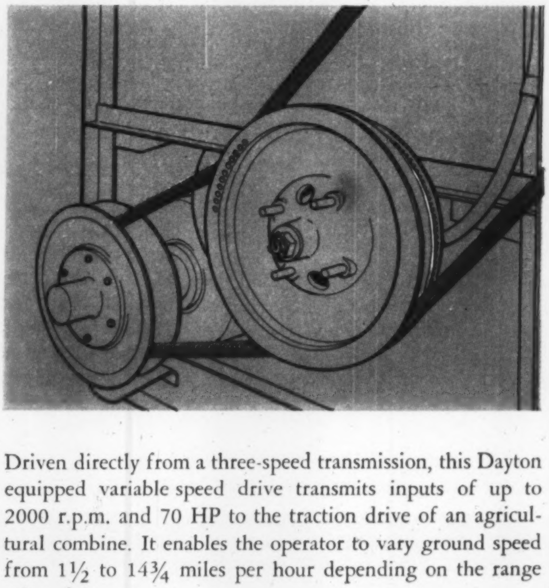
In the metalworking industry, Dayton Variable Speed Cog-Belt Drives are being adapted increasingly.

Why this revolution in speed-change mechanisms? Simply because Dayton Variable Speed Cog-Belts have proved . . . over and over again . . . that they provide a simpler, cheaper, faster way to vary speed and, most important of all, do it with predictable accuracy!

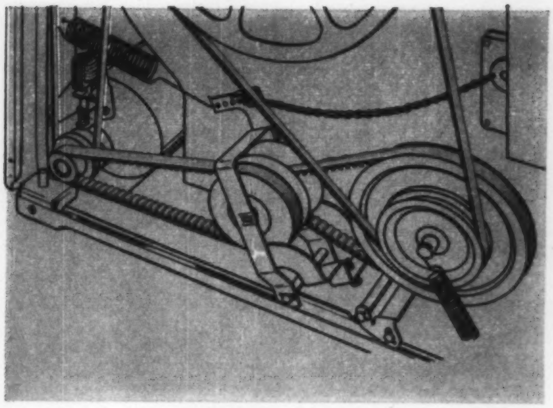
Dayton Variable Speed Cog-Belts offer:

- Extreme longitudinal flexibility needed for easy flexing around the sub-standard diameters often employed in variable flange sheaves.
- Maximum crosswise rigidity to prevent squashing and distortion under high axial pressures.
- The highest pull-out torque of any V-Belt made—due to the surer gripping power of the die-cut raw edges.

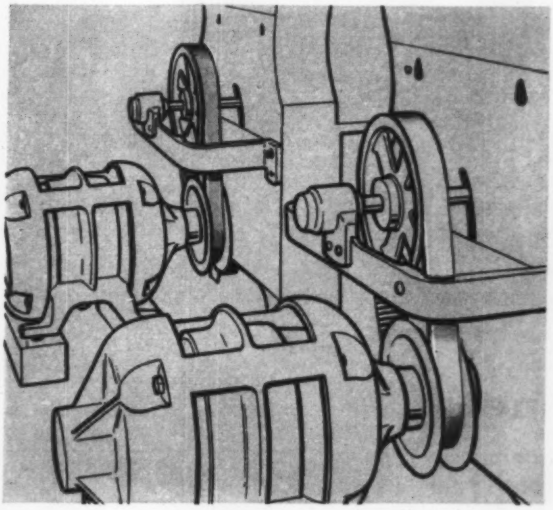
Call the Dayton engineer today and let him show you how you can improve and simplify your design with a Dayton Variable Speed Drive that's accurate at every point in your variable speed range.



Driven directly from a three-speed transmission, this Dayton equipped variable speed drive transmits inputs of up to 2000 r.p.m. and 70 HP to the traction drive of an agricultural combine. It enables the operator to vary ground speed from 1½ to 14¾ miles per hour depending on the range selected.

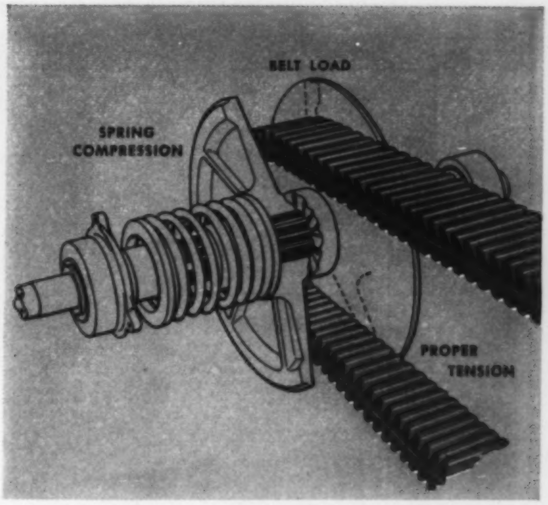


Instead of shifting gears, which have been eliminated in this combination washer-dryer, RCA Whirlpool employed this smooth-performing Dayton equipped variable speed drive to change drum speed from 45 r.p.m. during the tumble cycles to 200 r.p.m. during the spin cycles.

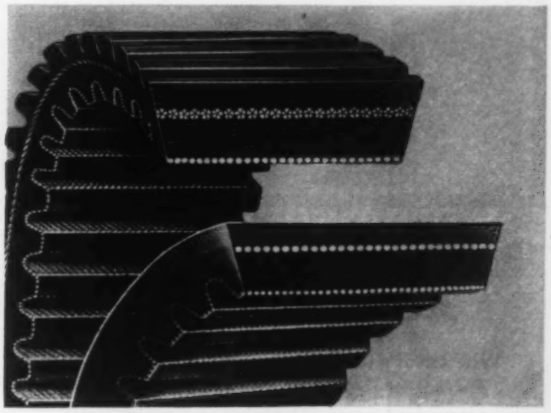


For years, textile spinning frames were driven by overhead flat belt drives . . . then interchangeable multiple V-Belt drives. Efficient Dayton Variable Speed Drives, capable of being adjusted within one r.p.m. of optimum speed for unvarying quality and maximum production, now provide the most up-to-date power transmission method.

® Registered



Engineered for maximum crosswise rigidity, Dayton Cog-Belts withstand heavy shock and impulse loads without squashing or deforming. This feature, plus surer gripping molded raw edges, gives double assurance of precise speed control under any operating condition.



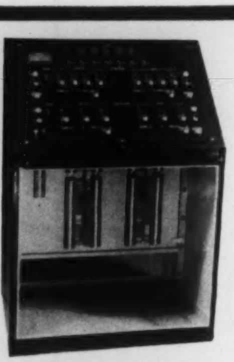
The exclusive Cog design gives Dayton Variable Speed V-Belts maximum lengthwise flexibility needed for bending around sub-standard diameter sheaves without strain or excessive heat build-up. This stronger, lighter-weight construction operates at speeds up to 2000 r.p.m. with a minimum of centrifugal force or internal stress.

Dayton Rubber

WORLD'S LARGEST MANUFACTURER OF V-BELTS

Industrial Sales Engineers in Atlanta, Chicago, Cleveland, Dallas, Dayton, Minneapolis, Moline, New York, San Francisco and St. Louis

Circle 437 on Page 19



Operating console used in automatic control of drying system. Control Panel Corporation also builds the custom-made cabinets.

Motor controller manufactured for the Navy under prime contract. Qty 107. All major operating components meet Navy "A" High Stock requirements. Assembly-line produced on sub-assembly basis.

This panel automatically controls newsprint paper conveyor at three stations. Controls include electric switching of conveyor routes. Entire system governed by interlocking photoelectric safety relays which prevent paper from bunching or running off conveyor terminals.

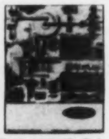
2 miles of wire in this free standing control panel for controlling "Detroit Type" transfer machine. Constructed to meet JIC Specifications. Used by automotive company in the manufacture of connecting rods. Completely wired and interconnected for checking before taking down for shipping.

Here's where *Reliable, Compact* Automatic Control Panels *Cost You Less!*

Whether it's design *and* assembly—or assembly to your existing design . . . Control Panel Corporation can guarantee reliable, compact control panels at less cost. And we can *meet* your due date.

This is possible simply because panel manufacturing is our *only* business. Our efficiency is high—so your cost is naturally lower. Furthermore, Control Panel Corporation provides the custom-made enclosures you want at prices competitive with ordinary stock enclosures. That's why scores of companies, big and small, keep coming back to Control Panel Corporation.

Best way of showing our potential use to you is by submitting our quotation or proposal covering your requirements—be it one thousand panels or one. There is no obligation, of course.



ASK FOR NEW BULLETIN

Lists Pantro uses and Pantro users. Shows a cross-section of the many types of automatic control panels. Pantro has designed or built for industry of all kinds.

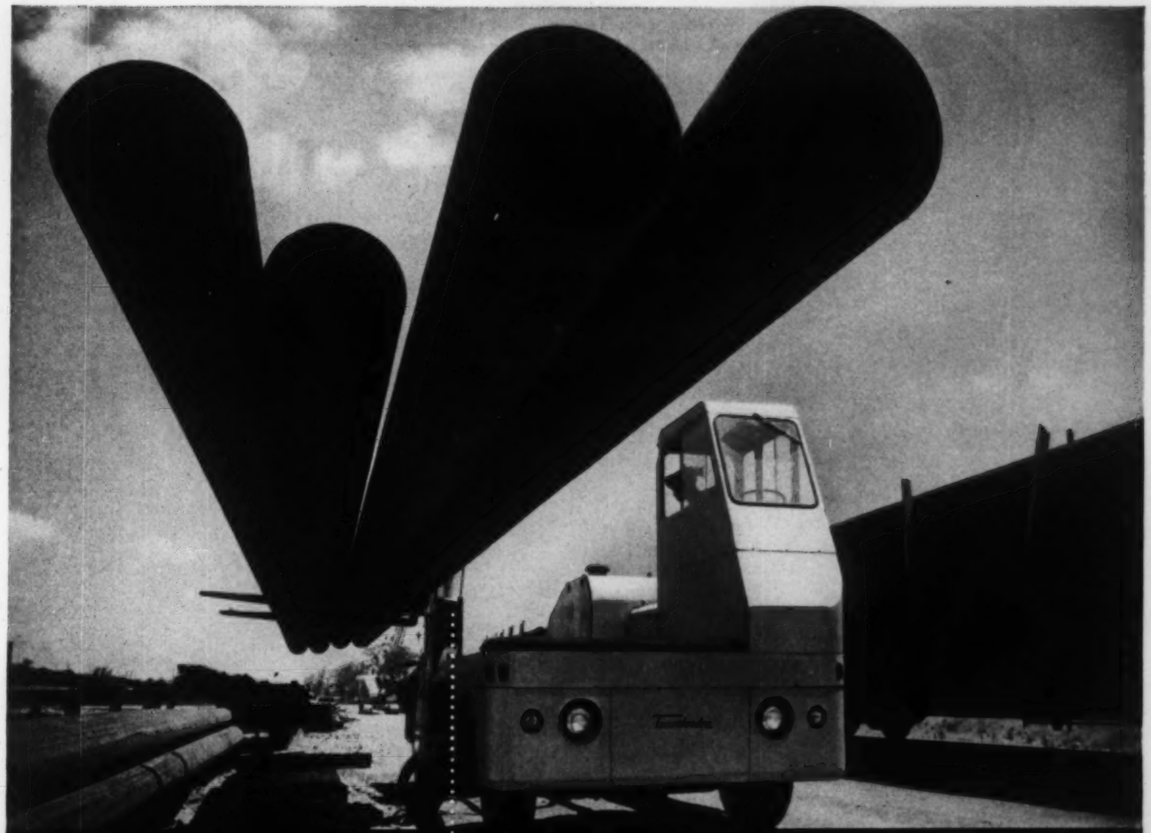
Pantro

CONTROL PANEL CORPORATION
517 W. Monroe St. • Chicago 6, Ill.

A Partial List of Pantro *Uses:*

- Bakery machinery
- Canning machinery
- Cement and clay working machinery
- Chemical machinery
- Confectionery and ice cream machines
- Construction and road-building machinery
- Flour, grain mill machinery
- Food products machinery, misc.
- Foundry machinery
- Machine tools
- Metalworking machinery
- Oil field machinery and tools
- Paper industries machinery
- Plastics molding machinery
- Printing trades machinery and equipment
- Rubber working machinery
- Special industry machinery
- Textile machinery
- Woodworking machinery
- Conveyors and conveying equipment
- Cranes, hoists, derricks
- Furnaces and ovens, industrial
- Hydraulic equipment, including pumps and controls
- Internal combustion engines
- Packaging and labelling machinery
- Locomotives and parts
- Railroad and steel cars and equipment
- Communications equipment
- Electronics equipment
- Motors, generators, motor generator sets

Circle 438 on Page 19



DYNAMIC DIFFERENCE

in hydraulic performance

"HC" SERIES

POSITIVE DISPLACEMENT GEAR-TYPE PUMP

Shaft seal: lip type
Drive: direct, gear or belt
Capacity: 5 sizes, 5 - 17 gpm
Pressures: to 1500 psi

Operating speeds: to 2400 rpm
Porting: side (Std.) end (Opt.)
Valve: Optional; internal relief, adjustable 800 - 1500 psi

BULLETIN HY1 gives complete engineering characteristics — performance and installation data.

Call the man from Webster

... he's one of a staff of engineers, specially trained in hydraulic application. He can help you solve special problems when hydraulics become a part of your design!

photo: Baker Industrial Trucks, div. of Otis Elevator Co., Cleveland, O.

Webster

POSITIVE DISPLACEMENT GEAR-TYPE PUMPS

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franklin adv. H-113

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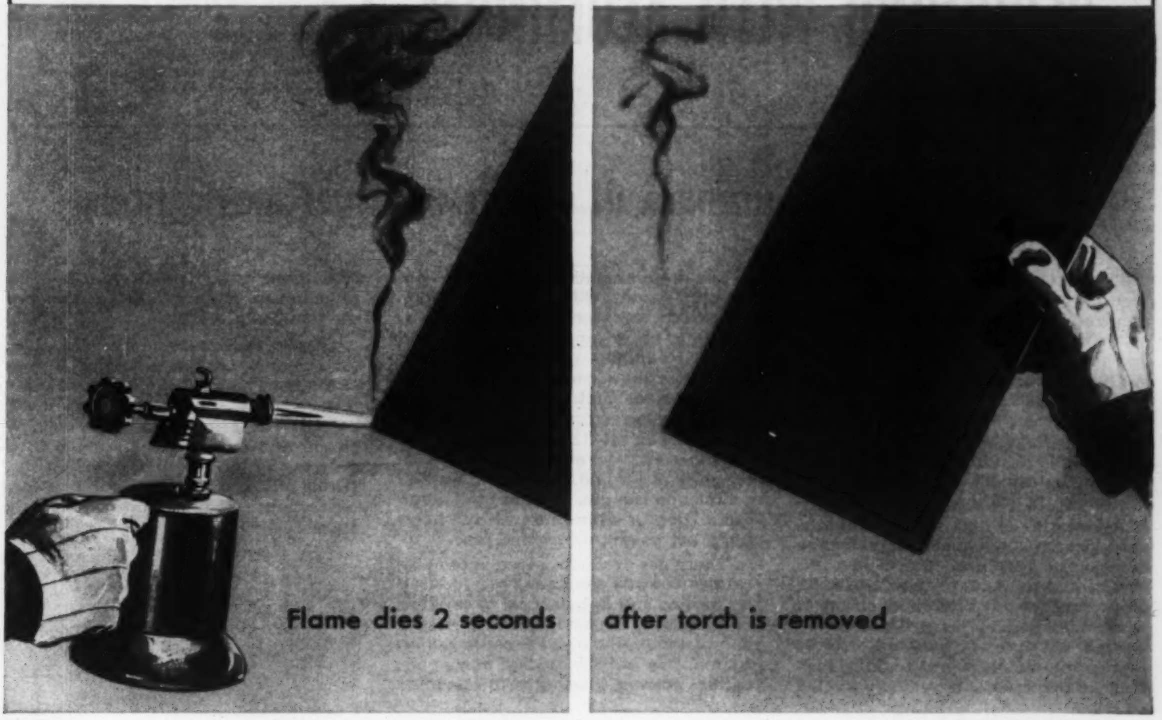

SELF-EXTINGUISHING G-11 EPOXY-GLASS LAMINATE RETAINS HIGH FLEXURAL STRENGTH AT 150°C.

New high-temperature *transparent* General Electric Textolite® 11559 has exceptional mechanical and electrical properties . . . developed especially for computer and military electronic printed circuits

High insulation resistance and flexural strength *even at 150°C.*—that's what you get with new General Electric Textolite Grade 11559 epoxy-glass electrical laminate. Self-extinguishing 11559 exceeds NEMA G-11 requirements and Specification MIL-P-18177, Type GEB. Here's how Grade 11559 performs:

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The base laminate withstands the effects of concentrated nitric acid and all conventional etching and plating solutions. In addition, 11559 is the only G-11 laminate that is *self-extinguishing*—has approximately 2-second flame-out time. Textolite Grade 11559 is available unclad or clad with 1 or 2 oz. copper.

Consult Sweet's Product Design File, Cat. 2b/Gen., for technical information on the complete line of Textolite laminates. Or for a brochure showing test data on Grade 11559—or engineering assistance for special problems—call or write: *Technical Service, Laminated Products Dept., General Electric Company, Coshocton, Ohio.*

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DESIGNING WITH ALUMINUM

This is one of a series of information sheets that discuss the properties of aluminum and its alloys with relation to design. Extra or missing copies of the series supplied on request. Address: Advertising Dept., Kaiser Aluminum & Chemical Sales, Inc., 919 N. Michigan Ave., Chicago 11, Illinois.

NO. 30

ALUMINUM IN LOW TEMPERATURE APPLICATIONS

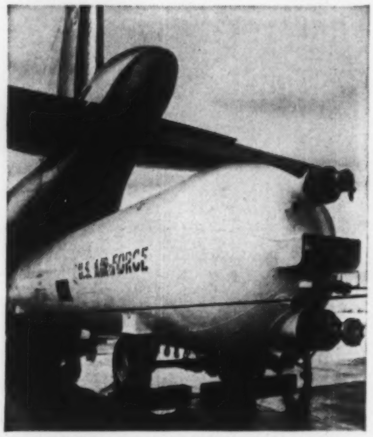
THE STRUCTURAL QUALITIES of aluminum and its alloys are actually improved at ultra-low levels of temperature, such as are encountered in the manufacture and handling of liquid gases. Tensile and yield strengths rise markedly, and percentage of elongation increases. As the lowest-cost metal capable of performing satisfactorily at temperatures below −150°F., aluminum is thus valuable to the rapidly expanding field of cryogenic applications.

Aluminum alloys also are unique among commercial metals in their combination of high strength-weight ratio, corrosion resistance, formability, weldability, reflectivity, and conductivity of heat and electrical energy. Also important for purposes of handling volatile liquids, aluminum is non-sparking, nonmagnetic and non-toxic.

The requirements of commercial gas applications are filled chiefly by four industrial gases (see Figure 1). Oxygen, nitrogen, argon and helium—in that order of volume—comprise much the greater portion of commercial gas manufacture. Oxygen, nitrogen and argon are among the gases that are produced by liquefying air at −320°F. to effect a separation of each gas at its individual boiling point as a liquid. Equipment for this production can use, and has used, large quantities of aluminum alloy sheet, plate, extrusions, tubing and pipe.

These gas products, along with natural gas (mostly methane) are reduced by cooling and liquefaction to volumes only about 1/600 to 1/800 of their gaseous volume. *And because consumption by industry in both old and new applications currently amounts to hundreds of millions of cubic feet annually,* this reduction in handling bulk is of immense economic importance.

One of the latest military missiles, for example, consumes 420 cubic feet of liquid oxygen . . . 336 thousand cubic feet as gas . . . in a 90-second firing period. These liquefied gases may be stored and moved in aluminum alloy double-shelled insulated tanks, thus taking advantage of their extreme concentration in the low-temperature liquid state.



Double-shelled mobile liquid-oxygen tank, produced with Kaiser Aluminum alloy 5086. Used in fueling missiles, this tank is being loaded for transport by air.

FIGURE 1

SOME PROPERTIES OF COMMERCIAL GASES

	BOILING POINT OF LIQUID GAS (Fahrenheit)	LIQUID DENSITY AT BOILING POINT (Lbs./cu.ft.)	GAS DENSITY* (Lbs./cu.ft.)	APPROX. VOLUME INCREASE, LIQUID TO GAS*
OXYGEN	−297	71.2	0.089	799
NITROGEN	−321	50.4	0.078	650
ARGON	−302	88.02	0.1114	770
HELIUM	−452	7.82	0.0111	700
NATURAL GAS (Chiefly Methane)	−265	25.9	0.0447	580

*Gas at normal temperature and pressure.

FIGURE 2

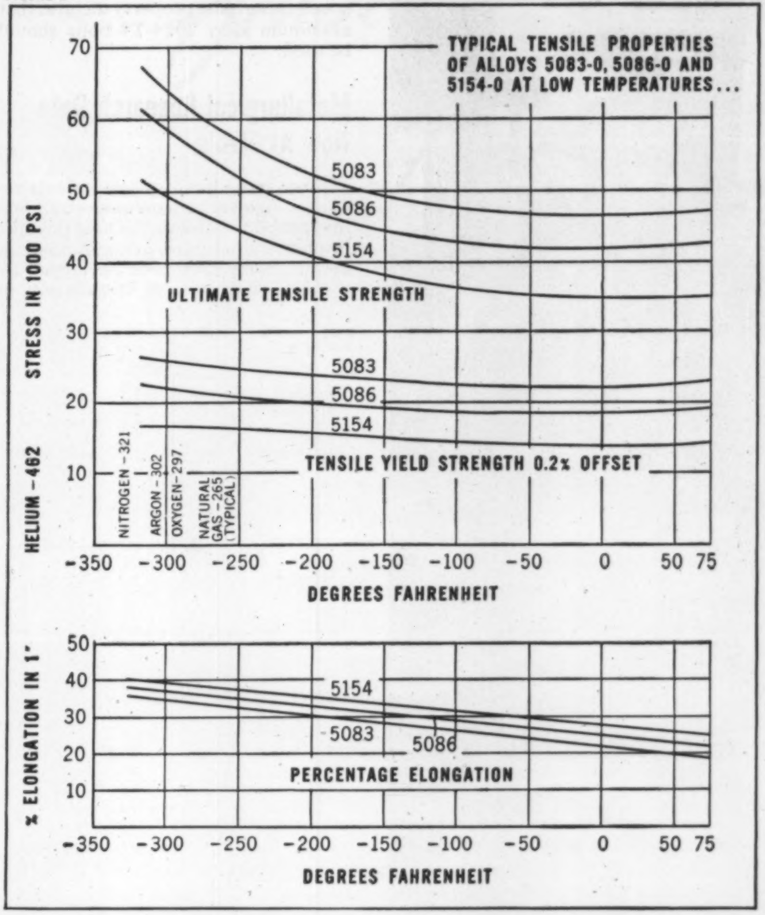
TYPICAL TENSILE PROPERTIES OF SOME ANNEALED ALUMINUM ALLOYS APPROVED BY ASME FOR UNFIRED PRESSURE VESSELS

ALLOY DESIGNATION AA	ASTM	ASME SECTION OR CASE NO.	TENSILE STRENGTH (psi) Ultimate	Yield	ASME ALLOWABLE DESIGN STRESS *VALUES (psi)	MINIMUM REQ'D WELDED TENSILE STRENGTH (psi)	PERCENT** ELONGATION
1100	990A	8	13,000	5,000	2,350	11,000	35
3003	M1A	8	16,000	6,000	3,150	14,000	30
3004	MG11A	8	26,000	10,000	5,650	23,000	20
5050	G1A	8	21,000	8,000	4,000	18,000	24
5052	GR20A	8	28,000	13,000	6,250	25,000	25
5154	GR40A	1174	35,000	15,000	7,350	30,000	27
5086	GM40A	1222	38,000	17,000	8,700	35,000	22
5083	GM41A	1247	42,000	21,000	10,000	40,000	22

*For metal temperature not exceeding 150°F.
**In 2 inch flat 1/16" gauge specimen at 75°F.

Nominal chemical compositions:
5154—Magnesium 3.5%, Manganese 0.05%, Chromium 0.25%
5086—Magnesium 4.0%, Manganese 0.45%, Chromium 0.15%
5083—Magnesium 4.45%, Manganese 0.75%, Chromium 0.15%

FIGURE 3



Several weldable aluminum alloys have been approved by the American Society of Mechanical Engineers as safe and suitable for construction of unfired pressure vessels such as are used in the handling of liquid gases.

Figure 2 tabulates typical tensile properties and the design stresses permitted by the ASME Code for some of these alloys, including high strength aluminum-magnesium compositions. All values shown are for metals in the annealed state. Kaiser Aluminum alloys 5083 and 5086 are the strongest ASME-approved aluminum-magnesium-manganese alloys that can be fabricated into these welded vessels by all normal methods, without need for stress-relieving or annealing. Both of these Kaiser alloys 5086 and 5083, when welded with 5183 filler, also meet the stringent "2T" bend test requirements for welds established by ASME for most other materials in these unfired pressure vessel applications.

The allowable design stress values shown are specified by ASME as acceptable for vessels and appurtenances from 150°F. down to -325°F. These permissible values are roughly two-thirds of the minimum guaranteed yield strength of the alloy at room temperature. Since the ultimate tensile and yield strengths of aluminum alloys increase as temperatures drop, the margin of safety rises still further at liquid gas temperature levels.

The low temperature behavior of alloys 5154, 5086 and 5083 is exemplified approximately in Figure 3. Ultimate strengths increase by about 50% from room temperature to -320°F. Yield strengths rise by about 18%. Thus, at the -320°F. level, the yield strengths of these three high-strength alloys approximate 2¼ times the stresses allowed for pressure vessel design by the ASME Code.

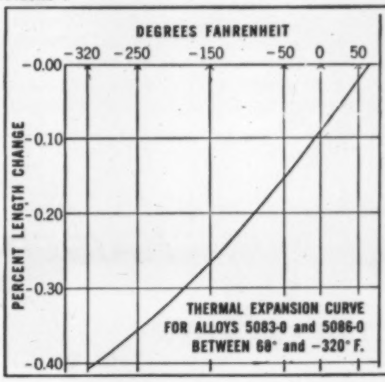
Through the same temperature range, percentage elongation properties have been shown by test to increase 60% or more, reaching the magnitude of 40% elongation at -320°F.

This added strength and ductility contribute much to structural dependability against both mechanical shock and large temperature differentials in different portions of the same aluminum part or system.

The thermal contractions encountered in ultra-low temperature equipment are larger than those to be accommodated in ordinary design applications. For example, an aluminum member 25 feet long contracts by about 1¼-inch through the range from 68° to -325°F. Figure 4 shows these thermal expansion characteristics, as typified by aluminum alloys 5086 and 5083.

The low elastic modulus of aluminum also contributes to its suitability for low-temperature equipment by mitigating the adverse effects of thermal contraction. Thermal deformations cause much smaller increases or decreases of stress in aluminum parts than in equivalent stainless steel parts. The representative #304 stainless steel listed in Table 4 will contract only about 70% as much as the high strength weldable aluminum alloys, for any given drop in temperature. However, the aluminum alloys have an elastic modulus of about 10,300,000 psi, roughly one-third that of the steel. Because of this difference in elastic moduli, the stress changes resulting from thermal deformation through any given temperature change

FIGURE 4



THERMAL EXPANSION COEFFICIENTS OF ALUMINUM ALLOYS AT LOW TEMPERATURES

Average Coefficients of Thermal Expansion ($x 10^{-6}$ per degree F.)

ALUMINUM ALLOYS	68° to -200° F.	68° to -320° F.
1099	11.8	10.5
3003	11.2	10.0
5083	11.6	10.4
5086	11.6	10.4
6061	11.3	10.2
#304 Steel (Stainless)	7.7	7.4

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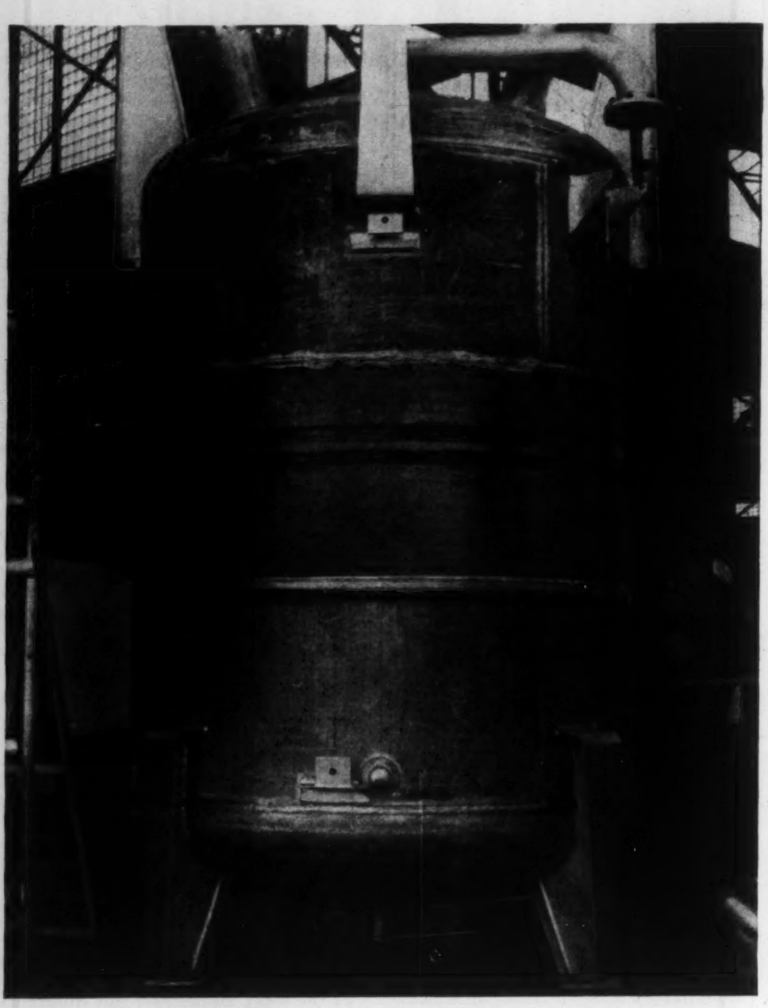


Assembly of welded aluminum vessel for a liquid-oxygen generating plant. Such plants serve the steel and chemicals industries.

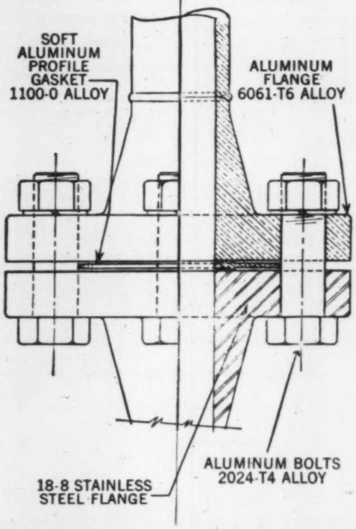
will be lower in the aluminum than in the steel.

One example of the advantages offered by this capacity for large elastic thermal deformations is the ability of aluminum alloy flanged joints, using 2024-T4 aluminum bolts, to maintain joint tightness under cyclical temperature conditions between 250°F. and −320°F. A bolt-loosening effect naturally occurs during the initial contraction of the pipe bore as it is cooled to liquid-gas temperatures, while the outer flange and the bolts remain relatively uncontracted at ambient levels. This tends to reduce gasket seating pressures. However, the loss of stress in aluminum bolts and flanges during thermal contraction of the pipe is much less than that occurring in equivalent steel parts. This ability to maintain stress during thermal deformations, along with the use of a soft aluminum profile gasket next to the bore, maintains adequate sealing while the flanges and bolts also cool. Since it often is desirable to bolt an aluminum flanged line to a stainless steel flanged line, for heat-dam purposes, this elastic property dictates that aluminum alloy 2024-T4 bolts should be used.

Metallurgical Research Data Now Available

Since most liquid-gas containers require a high vacuum between outer and inner shell to achieve the best possible insulating conditions, external pressure design charts have been developed by the Kaiser Aluminum Department of Metallurgical Research for each of the high strength alloys. These charts, and other information on aluminum use in low temperature applications, are available to interested manufacturers.

FIGURE 5


SOFT ALUMINUM PROFILE GASKET 1100-0 ALLOY
ALUMINUM FLANGE 6061-T6 ALLOY
ALUMINUM BOLTS 2024-T4 ALLOY
18-8 STAINLESS STEEL FLANGE

For immediate attention to your request for these charts and other technical information—or for engineering assistance in your own applications—contact the Kaiser Aluminum sales office listed in your telephone directory.

Kaiser Aluminum & Chemical Sales, Inc., *General Sales Office,* Palmolive Bldg., Chicago 11, Illinois; *Executive Office,* Kaiser Bldg., Oakland 12, Calif.

see our catalog in PRODUCT DESIGN FILE or write for copy

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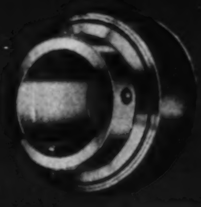

"L" BEARING

"SL" BEARING

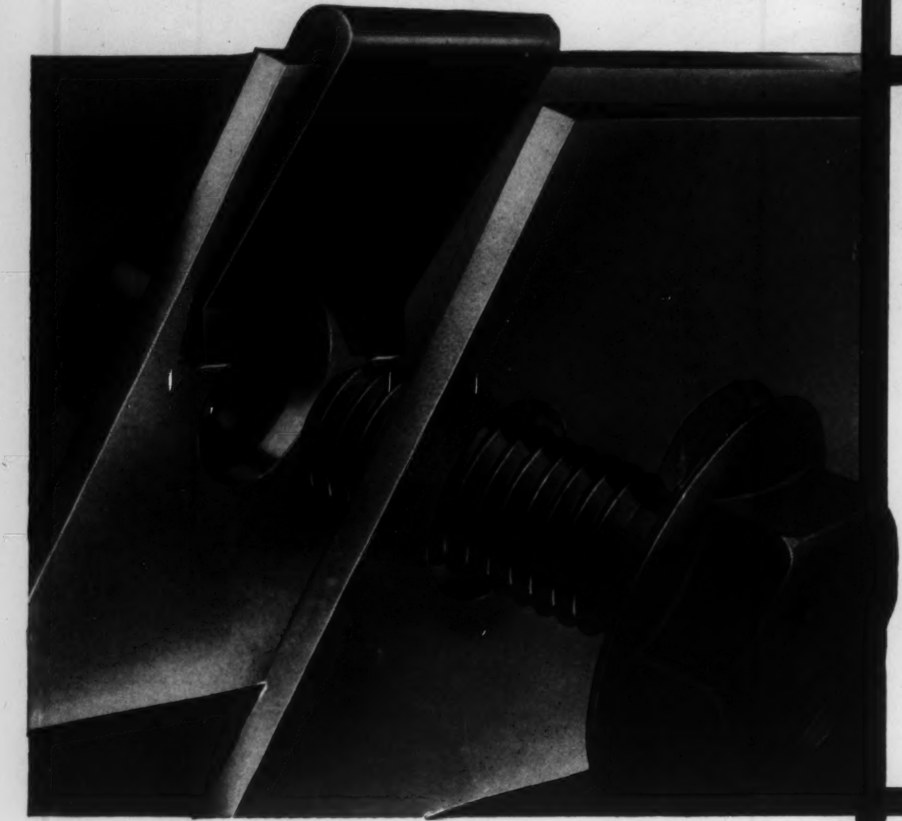
SEALMASTER
BALL BEARING UNITS

Write for Bulletin 1058

SEALMASTER BEARINGS A DIVISION OF STEPHENS-ADAMSON MFG. CO., 18 RIDGEWAY AVE., AURORA, ILLINOIS

Circle 443 on Page 19

DOT makes J NUTS with a difference



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- **SELF-TENSIONING**
- **LOW COST**
- **CAREFUL WORKMANSHIP**

It takes a little extra care in the drawing operation to make really reliable J-nuts in volume but it's well worth the trouble. It reduces internal strains in the barrel so that DOT J-nuts stand up to working loads considerably better than the average fastener of similar construction.

Available in three thread sizes (5/16″-18 and 24, 1/4-20) and to fit three ranges of material thickness (.030″ to .065″), DOT J-nuts are made of carbon steel. They hold themselves in place over stamped holes so that preassembly is practical in cases where the actual bolting operation comes at the end of a series of other operations.

Full details on request.

CARR FASTENER COMPANY

Division of United-Carr Fastener Corporation, Cambridge 42, Mass.

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"Steel quality is all important to the designer," says Albert Coleman, Director of Engineering at Whirlpool's Clyde, Ohio plant, "and we've found we can trust Sharon to deliver what they promise."

Sharon engineers know the importance of working in close coordination with engineers like Mr. Coleman to thoroughly understand the application and then make certain the steel supplied will do the job for which it was intended.

Better appliances depend on steel. Leading appliance makers, like Whirlpool, have learned they can depend on quality steels—consistently—from the mills of the *Sharon Steel Corporation, Sharon, Pa.*

SHARONSTEEL **SHARON** *Quality* **STEEL**

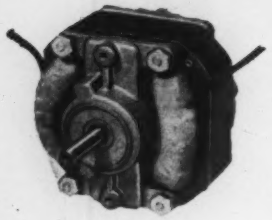
Circle 444 on Page 19

New! Complete, Expanded Line of Shaded

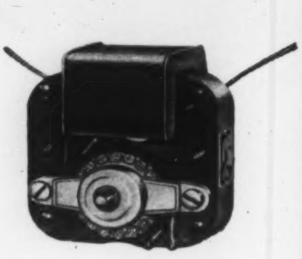
HOWARD

Newly expanded with the recent additions of the former Fairchild and Scruggs models, the all-inclusive Howard line of shaded pole and induction motors is now the most comprehensive in the industry. The wide selection of standard shaded pole and induction models offered by Howard assures you of a motor to meet your exact requirements at low cost and with minimum delay. Thousands of specs are on file so that variations of any standard model can also be quickly and inexpensively supplied. Shown on these pages are just a few of the shaded pole and induction motors in the Howard line. For samples and prices or information on these or other Howard motors—Universal, Gear motors or Blowers (not shown)—send us details of your application today.

Shaded Pole Motors 1/2000 to 1/8 H.P.

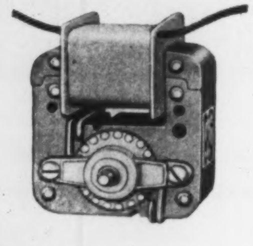


MODEL 100
TYPE: 4 pole, double bearing
DIAMETER: 2-3/4 square
LENGTH: 2-5/32 to 2-29/32 depending on stacking
H.P.: 1/650 to 1/85
NO LOAD RPM: 1700
FULL LOAD RPM: 1500 standard
BEARINGS: Sintered bronze, self-aligning type or ball bearings. Extension oil tubes available.

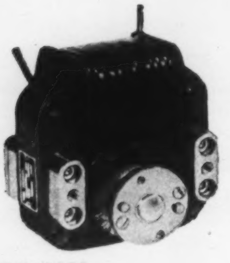


MODEL 1000
TYPE: 2 pole, double bearing
WIDTH: 2-3/8
HEIGHT: 2-19/32
LENGTH: 1-5/8
H.P.: 1-1000 to 1/75
NO LOAD RPM: 3400 - 3500
FULL LOAD RPM: 2800 - 3200
BEARINGS: Oilite with large oil reservoir.

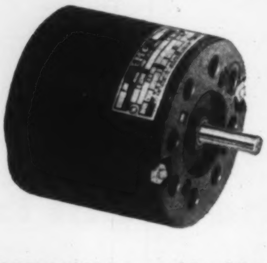
MODEL 1075
TYPE: 2 pole, unit bearing
WIDTH: 2-3/8
HEIGHT: 2-5/8
LENGTH: 1-3/4
H.P.: 1/750 to 1/185
NO LOAD RPM: 3400
FULL LOAD RPM: 2600 - 3200
BEARINGS: Unit bearing construction with permanently sealed-in lubrication.



MODEL 1100
TYPE: 2 pole, double bearing
WIDTH: 2-1/2
HEIGHT: 2-15/16
LENGTH: 1-1/2 to 2 depending on stacking
H.P.: 1/750 to 1/50
NO LOAD RPM: 3400
FULL LOAD RPM: 2800 - 3200
BEARINGS: Oilite with large oil reservoir.



MODEL 1175
TYPE: 2 pole, unit bearing
WIDTH: 2-1/2
HEIGHT: 2-31/32
LENGTH: 1-49/64 to 2-5/8 depending on stacking
H.P.: 1/700 to 1/100
NO LOAD RPM: 3400
FULL LOAD RPM: 2600 - 3200
BEARINGS: Unit bearing construction with permanently sealed-in lubrication.



MODEL 2800S Stamped Steel Case
TYPE: 2 pole or 4 pole shaded pole
DIAMETER: 3-9/32
LENGTH: 2-3/16 to 3-1/16 depending on stacking
H.P.: 1/100 to 1/30*
NO LOAD RPM: 1700 or 3400
FULL LOAD RPM: 1500 or 3000
STARTING TORQUE OZ. IN.: 2.0 - 10.0 depending on stacking
BEARINGS: Porous bronze sleeve type with large oil reservoir.

*Ratings are continuous duty, 55° C rise in a 40° ambient, with air drawn over the open ventilated motor.

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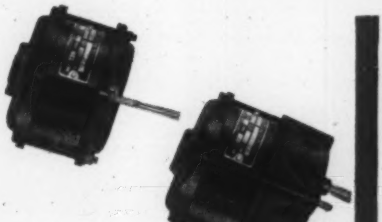


MODEL 2400

TYPE: 4 Pole Induction

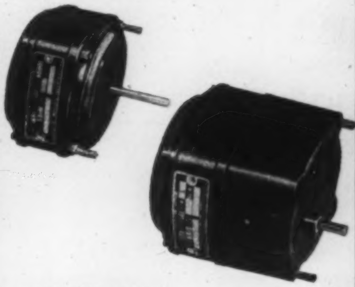
DIAMETER: 2-9/16" square.

LENGTH: 2-3/8" to 3".

SINGLE PHASE CAPACITOR MOTOR.
Maximum Torque oz in.—1.
Full Load Speed R.P.M.—1150.
Bearinge—RBC—Ball. RWC—Sleeve.

TWO PHASE MOTOR:
Maximum Torque oz. in.—1.5.
R.P.M.—1150.
Bearings—RBC—Ball. RWC—Sleeve.

BEARINGS: Porous bronze sleeve type with oil reservoir, or grease sealed ball bearings.



MODEL 2500

TYPE: 2 pole or 4 pole induction.

DIAMETER: 2-9/16" square.

LENGTH: 1-7/8" to 2-3/8".

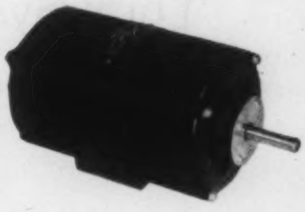
SPEED: *1200 to 3600 R.P.M.

H.P.: 1/300 to 1/1400.

MAXIMUM TORQUE OZ. IN.: *1.6 to 3.5.

BEARINGS: *Ball or sleeve.

*Dependent on type of motor used, i.e. Non-Synchronous Capacitor Motors, Torque Motors, Standard Synchronous Motors, Hysteresis Synchronous Motors.



MODEL 2900

TYPE: 2 Pole, 4 Pole, 6 Pole or 8 Pole Induction.

DIAMETER: 3-5/16".

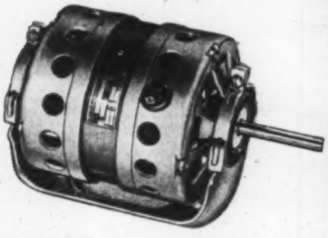
LENGTH: 4-25/32" to 5-21/32" ball bearing.
5-5/16" to 6-3/16" sleeve bearing.

H.P.: *1/70 to 1/15.

FULL LOAD TORQUE OZ. IN.: *10.0 to 30.

BEARINGS: Bronze sleeve type with oil reservoirs, or permanently lubricated sealed and shielded ball bearings.

*Dependent on type of motor used: i.e. Non-Synchronous Capacitor Motors, Standard synchronous, Motors, Hysteresis Synchronous Motors. Torque Motors.



MODEL 3700

TYPE: 2 Pole, 4 Pole, 6 Pole or 8 Pole Induction.

DIAMETER: 3-7/8".

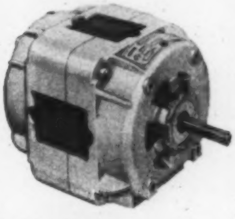
LENGTH: 5-1/16" to 5-11/16".

H.P.: *1/25 to 1/7.

STARTING TORQUE: *13 oz. in. to 30 oz. in.

BEARINGS: Porous bronze type with oil reservoir.

*Dependent on type of motor used; i.e. Normal Induction Motor, Hysteresis Synchronous Motor.



MODEL 9200

TYPE: Induction, torque, synchronous 2, 4, 6 or 8 poles, 25 to 60 cy single (capacitor) two or 3 phase.

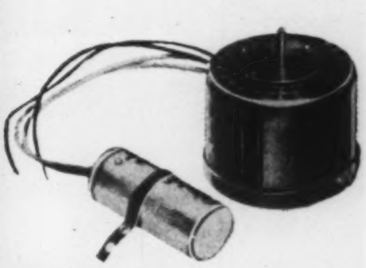
H.P.: 1/250 to 1/50 continuous or intermittent duty.

R.P.M.: 900 to 3600.

DIMENSIONS: 2-7/8" x 2-7/8" by 4-1/32" to 4-13/32".

MOUNTING: Pad, resilient ring, face extended bolts.

BEARINGS: Porous bronze sleeve, (ball bearings available at request).



MODEL I

TYPE: Hysteresis Type Single Phase Capacitor

DIAMETER: 2-5/8

LENGTH: 2-3/16

H.P.: 1/500 to 1/200

SPEED: 3600 RPM

FULL LOAD TORQUE OZ. IN.: .6 to 1.35

BEARINGS: Sleeve or ball.

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DIVISIONS: EMC ELECTRIC MOTOR CORPORATION · CYCLOHM MOTOR CORPORATION · RACINE ELECTRIC PRODUCTS · LS LOYD SCRUGGS COMPANY

Circle 445 on Page 19

Many a manufacturer reports that installing a Fenwal THERMOSWITCH unit resulted in *immediate improvement in the performance of his equipment!*

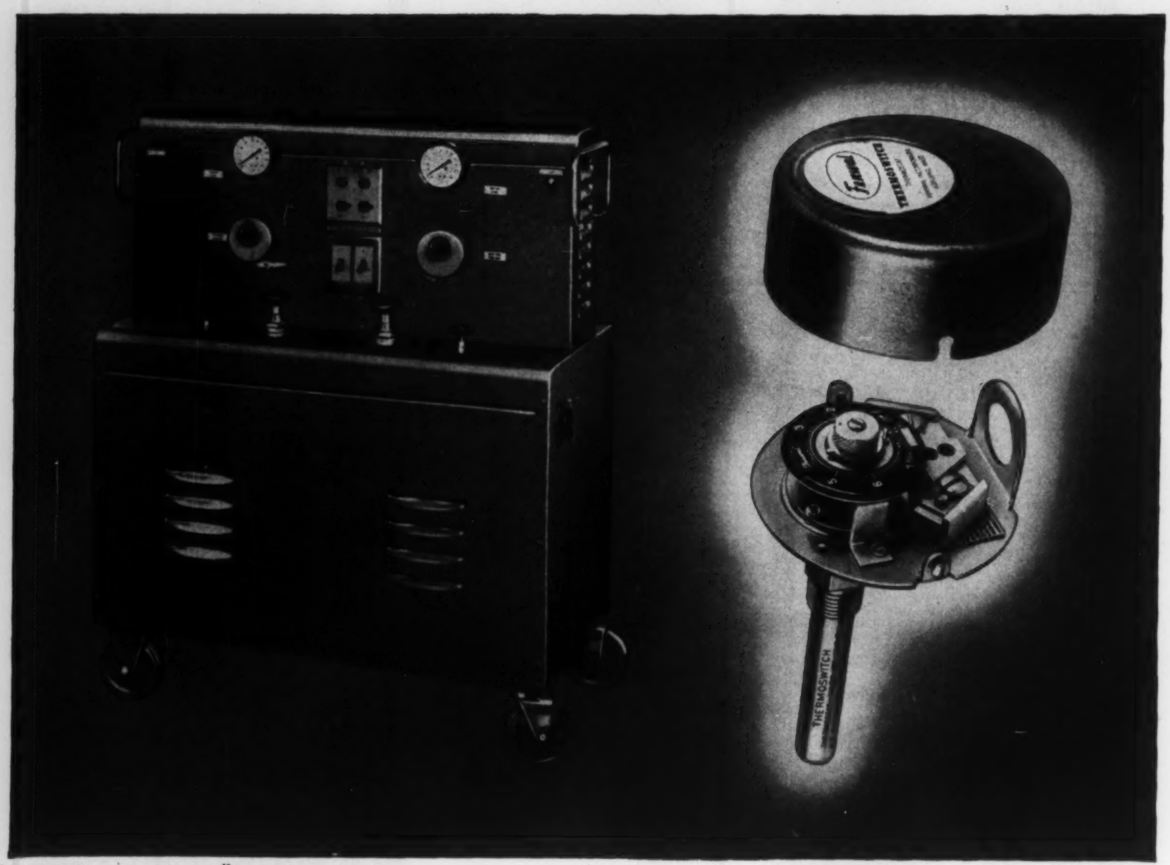
"Immediate" is right. Rapid response is one big advantage because the outer shell is the temperature sensing member. Extreme sensitivity — within a fraction of a degree — is another. That's because the slightest movement of the shell opens or closes contacts. And within its operating range, a THERMOSWITCH unit is field adjustable, yet has a sealed tamper-proof assembly to retain its sensitivity and precision through a long, useful life. Operating range is from −100°F to 600°F . . . *three to five times that of any ordinary thermostat!*

Applications for easy-to-install THERMOSWITCH units are virtually limitless . . . not only to "tone up" existing thermal systems, but to insure the long, reliable life that industry requires. For more facts write to Fenwal Incorporated, 194 Pleasant Street, Ashland, Mass., asking for a catalog, a sales engineer, or both.

Tone Up Your System

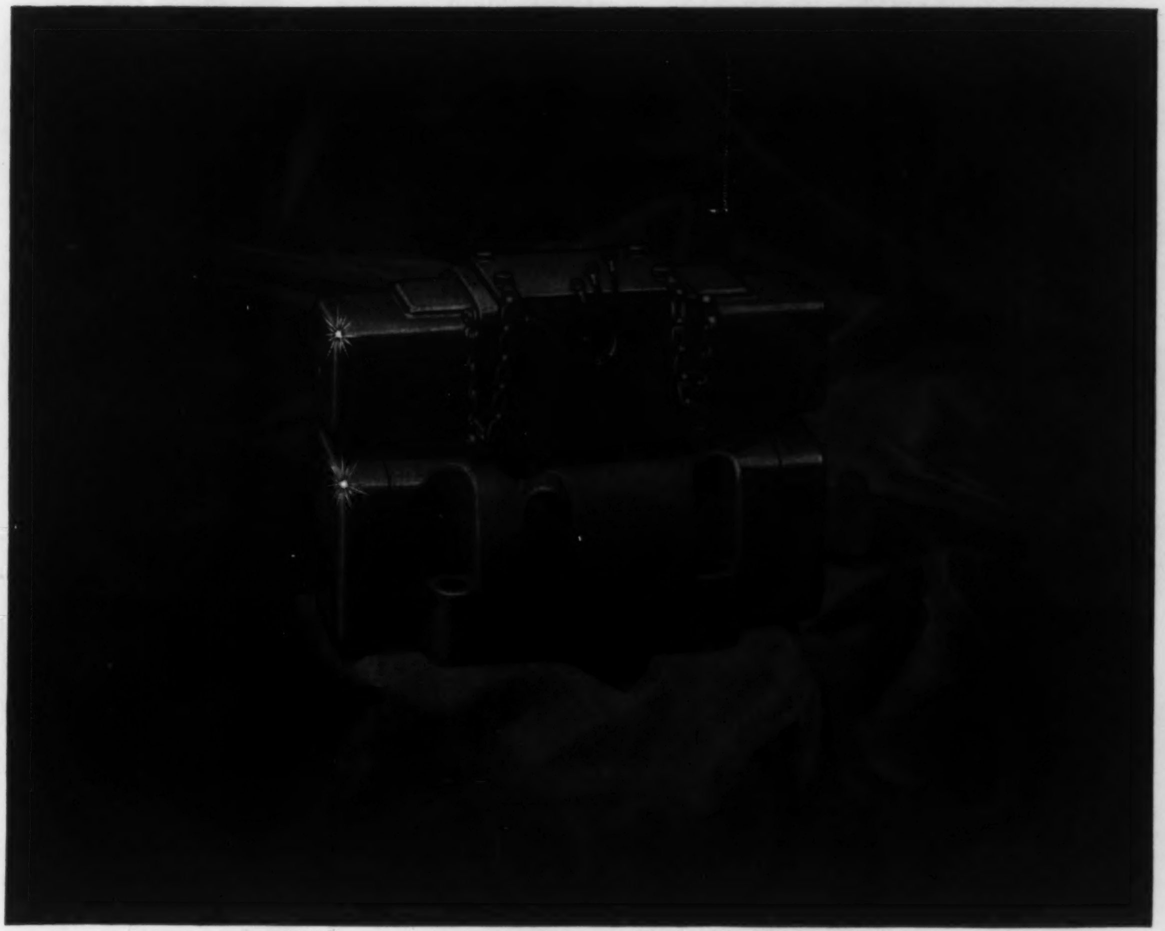
. . . any thermal system . . . with a sensitive, precise THERMOSWITCH® unit

In this Sterlco Control, an automatic self-contained unit for heating or cooling water to maintain a constant temperature while circulating it continuously through a plastics forming mold, "a Fenwal THERMOSWITCH unit, No. 17800 with dial and knob, fills our requirement for a sensitive, reliable, long-lasting thermostat." So says Sterling, Inc., Milwaukee, Wis.



ANOTHER EXAMPLE OF HOW **Fenwal** CONTROLS TEMPERATURE . . . PRECISELY

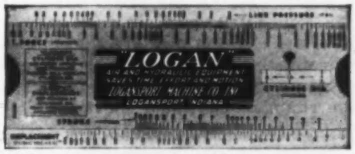
Circle 446 on Page 19



Illustrated—New 9700 Series
Piggy Back Hydraulic Control Valve
Meets J.I.C. Standards

Look to Logan

the ultimate in hydraulic valve design


LINE PRESSURE
"LOGAN"
AIR AND HYDRAULIC EQUIPMENT
SAVES TIME EFFORT AND MOTION
LOGANSPORT MACHINE CO INC
LOGANSPORT, INDIANA
STROKE
DISPLACEMENT

FREE **SEND FOR THE "LOGAN CALCULATOR"**
A gift to you from Logansport Machine Company upon request.

MEMBER: Natl. Mach. Tool Builders Assn.; Natl. Fluid Power Assn.

LOGANSPORT MACHINE CO., INC.
811 CENTER AVENUE, LOGANSPORT, INDIANA

PLEASE SEND COPY OF CATALOG:

- ☐ 100-1 AIR CYLINDERS
- ☐ 100-2 MILL-TYPE AIR CYLS.
- ☐ 100-3 AIR-DRAULIC CYLS.
- ☐ 100-4 AIR VALVES
- ☐ 100-5 LOGANSQUARE CYLINDERS
- ☐ 100-5-1 ULTRAMATION CYLINDERS
- ☐ 51 PRESSES
- ☐ FACTS OF LIFE
- ☐ 62 SURE-FLOW PUMPS
- ☐ 200-1 HYD. POWER UNITS
- ☐ 200-2 ROTOCAST HYD. CYLINDERS
- ☐ 200-3 750 SERIES HYD. CYLINDERS
- ☐ 200-4 and 200-7 HYD. VALVES
- ☐ 200-6 SUPER-MATIC CYLS.
- ☐ 70-1 CHUCKS
- ☐ ABC BOOKLET
- ☐ CIRCUIT RIDER

TO:

NAME________________ TITLE__________

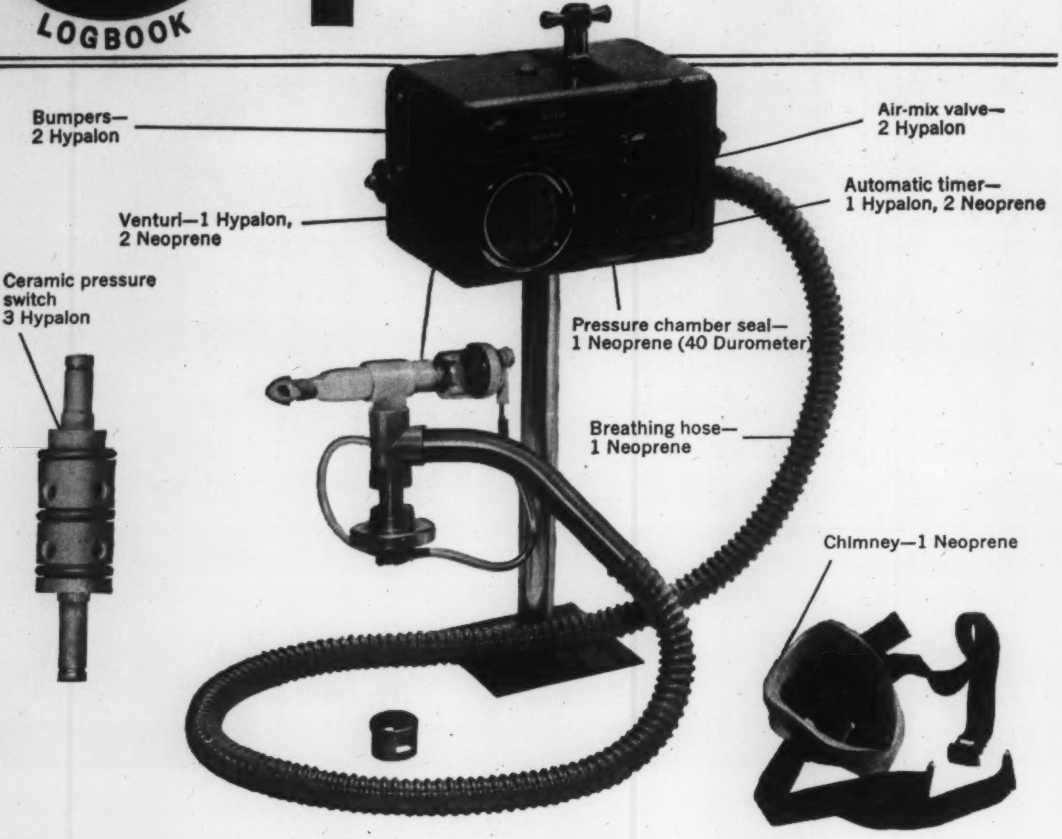
COMPANY ________________________

ADDRESS ________________________

Circle 447 on Page 19

NATIONAL OIL SEAL® LOGBOOK

For a precision respirator


Bumpers—
2 Hypalon
Air-mix valve—
2 Hypalon
Automatic timer—
1 Hypalon, 2 Neoprene
Venturi—1 Hypalon,
2 Neoprene
Ceramic pressure
switch
3 Hypalon
Pressure chamber seal—
1 Neoprene (40 Durometer)
Breathing hose—
1 Neoprene
Chimney—1 Neoprene

Uses National Hypalon O-Rings for dependability in home and hospital

20 million cycles of perfect operation. Years of shelf life. Sporadic operation—long idleness, prolonged periods of operation. Extreme sensitivity, precision mechanism. Regular exposure to oxygen, ozone, medication. Reliability that can literally mean life or death.

These are some of the requirements National® O-Rings meet in the revolutionary new Bird MARK 7® Respirator. Introduced little over a year ago, the compact, light-weight Bird MARK 7 is in use throughout the Free World and is hailed by anesthesiologists, surgeons and hospitals as a major advance in therapy for serious disorders such as polio, pneumonia, other lung disorders and coronary problems affecting breathing.

National Welding Equipment Company, makers of the Bird respirator, state that the high order of dependability could not have been achieved without National Hypalon O-Rings. In addition to their stability vs. oxygen, moisture, medications and gases, the Hypalon rings are rugged, and are not damaged when press-installed over extreme-hardness ceramic bushings.

A total of 15 National O-Rings are used in the Bird MARK 7. Nine are Hypalon, five are conventional 70 Durometer neoprene rings and the 15th is a large 40 Durometer Neoprene ring used as a static seal between the pressure chamber and main chassis.

National O-Rings are available in standard sizes, commercial grade, or in special compoundings including Hypalon. For details or O-Ring engineer assistance, call the nearest National Seal engineer. Look in the Yellow Pages, under Oil Seals or O-Rings.

6162

NATIONAL SEAL
Division, Federal-Mogul-Bower Bearings, Inc.
General Offices: Redwood City, California
Plants: Redwood City and Downey, California
Van Wert, Ohio

NATIONAL
OIL SEALS

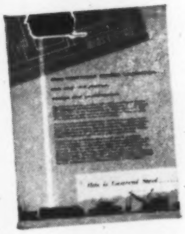
. . . where industrial progress is cast in steel

APPLICATION ANALYSIS . . . AS YOU LIKE IT

A thorough analysis of application and design problems is necessary for the development of optimum structural designs. Experienced personnel . . . sales, engineering and manufacturing . . . drawing from General Steel's more than 50 years of experience, are fully prepared to evaluate the structural requirements of your product. Their recommendations will enable you to build a better product, taking full advantage of the many benefits to be gained through the use of steel castings.

General Steel works from your specifications, or better still, starts from scratch to help you plan components of your products whether they be cast steel, cast-weld or composite structures. Our complete service . . . a unique blending of research and development, creative design, quality production and follow-through in the field . . . complements the initial application analysis.

Whatever your present or future plans, let us show you what steel castings . . . and General Steel . . . can do for you.



Write for folder:
How General
Steel Castings
Can Improve
Product Design
and Performance.
General Steel Castings
Station 260
Granite City, Illinois

GENERAL STEEL CASTINGS

GRANITE CITY, ILL. • EDDYSTONE, PA. • AVONMORE, PA.

Technical data for gasket design and selection

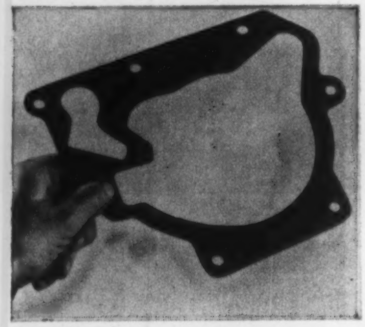
Choosing a gasket for aluminum flanges

The use of aluminum flanges—particularly temperatures of 300° F. or above—creates some new problems in gasket engineering.

As heat is applied to an aluminum assembly, expansion has the effect of substantially increasing the unit load above that usually attained by the initial torquing operation. This higher load usually causes conventional fiber materials to crush and extrude, resulting in serious loss of bolt torque.

Effective sealing under such conditions requires a dense material with unusual resistance to crushing at high temperatures. A material that meets these requirements is Accopac AN-890, a new Armstrong asbestos gasket.

Under test loads of 100,000 psi at temperatures of 350° F., AN-890 shows no noticeable extrusion or crushing. Indications are that the excellent torque retention properties of AN-890 would not be impaired even at much higher temperatures.



AN-890 is made by a beater-saturation process pioneered and patented by Armstrong. This method coats the fibers uniformly with a nitrile-type latex rubber binder and links them so tightly that crushing and extrusion are eliminated in normal applications.

With all its advantages, AN-890 costs less than conventional compressed asbestos sheet materials. For more information, send for a copy of bulletin IND-915.

How thickness affects performance of cork-and-rubber and rubber gaskets

Where cork-and-rubber or straight rubber gaskets are used, it should not be assumed that greater sealability will be achieved merely by increasing the thickness of the gasket. Actually, it is possible for a too-thick gasket to have just the opposite effect.

LBS./SQ. IN. / MATERIAL	2,000	4,000	6,000	8,000	10,000	12,000	16,000	20,000	24,000	28,000	30,000
1/8"	●	●	●								
1/16"	●	●	●	●	●	●					
1/32"	●	●	●	●	●	●	●	●	●	●	●

Results of a hot extrusion test on a cork-and-rubber gasket material. Tests were conducted at 200° F., with thickness the only difference between the samples.

Armstrong research engineers point out a number of disadvantages that may be encountered when gaskets are thicker than they need be.

The first of these is obviously economic. Since a thick gasket costs more than a thin one, using a thicker gauge than needed is obviously a waste of money. In addition, such a gasket may cause trouble in three major ways: (1) by extruding and crushing; (2) by allowing excessive torque loss, and (3) by encouraging flange misalignment.

Extrusion. The tendency for a rubber or rubber-like gasket to crush or extrude increases as the gauge increases, as shown in the chart above. Note that the 1/8" sample crushes at 6,000 psi, while it takes 30,000 psi to crush the same material in 1/32" gauge.

Torque Loss. Although some torque loss occurs with any non-metallic gasket material, a too-thick gasket will almost always aggravate the problem. As a result, leaks occur or frequent retorquing of bolts becomes necessary. In laboratory checks at the Armstrong Research and Development Center, it was found that over-gauge gaskets were a factor in almost every case of excessive torque loss.

Flange Alignment. Cocking, flange misalignment, and non-parallelism are most commonly caused by the failure to follow a standard torquing sequence. This often happens in maintenance work, such as replacement of pipe flange gaskets.

The risk of misalignment increases if a gasket is thicker than it needs to be. This is because, with rubber or rubber-like gaskets, the thicker the gasket, the greater the flange load needed to create a seal. And the danger of misalignment increases as the flange load goes up.

Thus, the gauge of a gasket is an important factor in gasket selection and must be considered carefully. Generally speaking, the thinnest gasket that can be tolerated is suggested. Where necessary, it might be advisable to test various thicknesses.

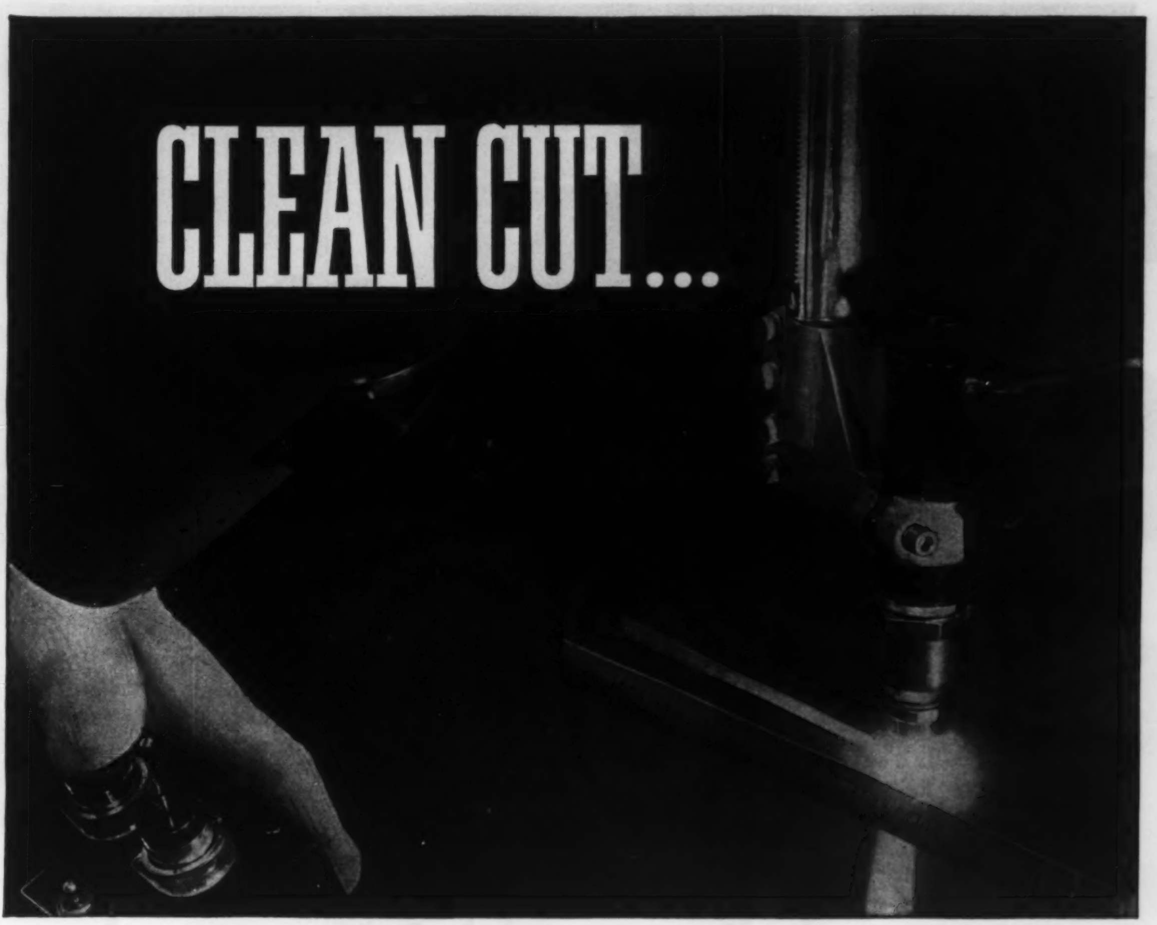
We will be glad to give suggestions on your specific problems if you will send details to us.

For your copy of the Armstrong Gasket Design Manual, write to Armstrong Cork Company, Industrial Division, 7004 Dean Street, Lancaster, Pa.

GASKET
DESIGN
MANUAL

Armstrong GASKET MATERIALS

. . . used wherever performance counts



... HELIARC Cutting turns hours to minutes

Before: It took 1½ hours to chip an 18-inch hole in an aluminum dome ⅝-inch thick. NOW—The hole is cut in *one minute*—with HELIARC Cutting.

Before: A 54-inch diameter dome hole in ⅝-inch rolled aluminum plate required about 5 hours, with chipping hammers. NOW—Manual HELIARC Cutting does it in about 4½ *minutes.*

HELIARC Cutting employs an extremely high-temperature, high-velocity arc that gives cutting speeds up to 1000 inches per minute on ¼-inch-thick material. It makes saw-like cuts, either square or beveled, in materials up to 3 inches thick ... *and,* you can take the torch to the work. "HELIARC Cutting is equally effective on aluminum, stainless steel, magnesium, copper and all other metals."

See for yourself—ask your nearest LINDE representative to *prove* that HELIARC Cutting slashes time and labor costs over conventional methods. Call your local LINDE office today! Or write Dept.Q43, LINDE COMPANY, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, N. Y. Offices in other principal cities. In Canada: Linde Company, Division of Union Carbide Canada Limited.

Linde
TRADE-MARK

UNION
CARBIDE

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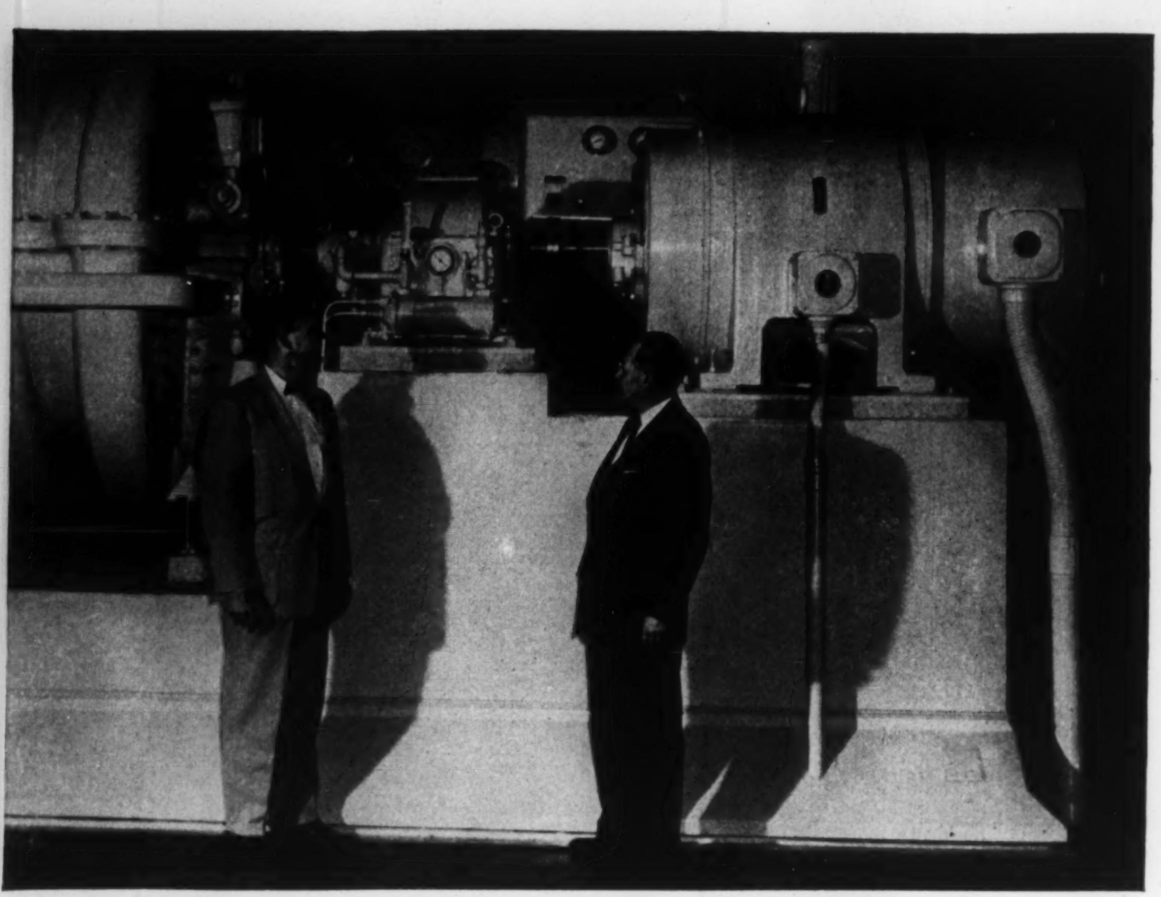

One of two Fairbanks-Morse 4160 volt, 700 hp. slip ring motors which power Carrier refrigeration compressors.

8-speed climate with F-M motors!

Flexible control of new air conditioning system saves power and maintenance for Union Oil Center

Through a new Carrier dual-duct high-velocity system powered by Fairbanks-Morse slip ring motors, the magnificent new Union Oil Center in Los Angeles is ideally air-conditioned at minimum power and maintenance cost.

Providing 8 speeds between 75 and 100 percent of capacity, the two F-M 700 hp. motors make it possible to match operating rpm. of compressors, chillers and condensers to any specific condition. The new Center covers 5 acres, with 1200 employees occupying 426,000 square feet of the office space in a complex of four buildings—an installation requiring the finest in air-conditioning equipment and components.

Fairbanks-Morse offers the distinct advantage of a broad range of alternating and direct current motors, in all types, and in ratings from ½ to 10,000 hp.

For expert assistance in specifying, write Fairbanks, Morse & Co., 600 South Michigan Ave., Chicago 5, Illinois.

New Union Oil Center in Los Angeles.

FAIRBANKS-MORSE

a name worth remembering when you want the BEST

ELECTRIC MOTORS · GENERATORS · PUMPS · SCALES · DIESEL, DUAL FUEL AND GAS ENGINES · LOCOMOTIVES · COMPRESSORS · MAGNETOS · HOME WATER SYSTEMS

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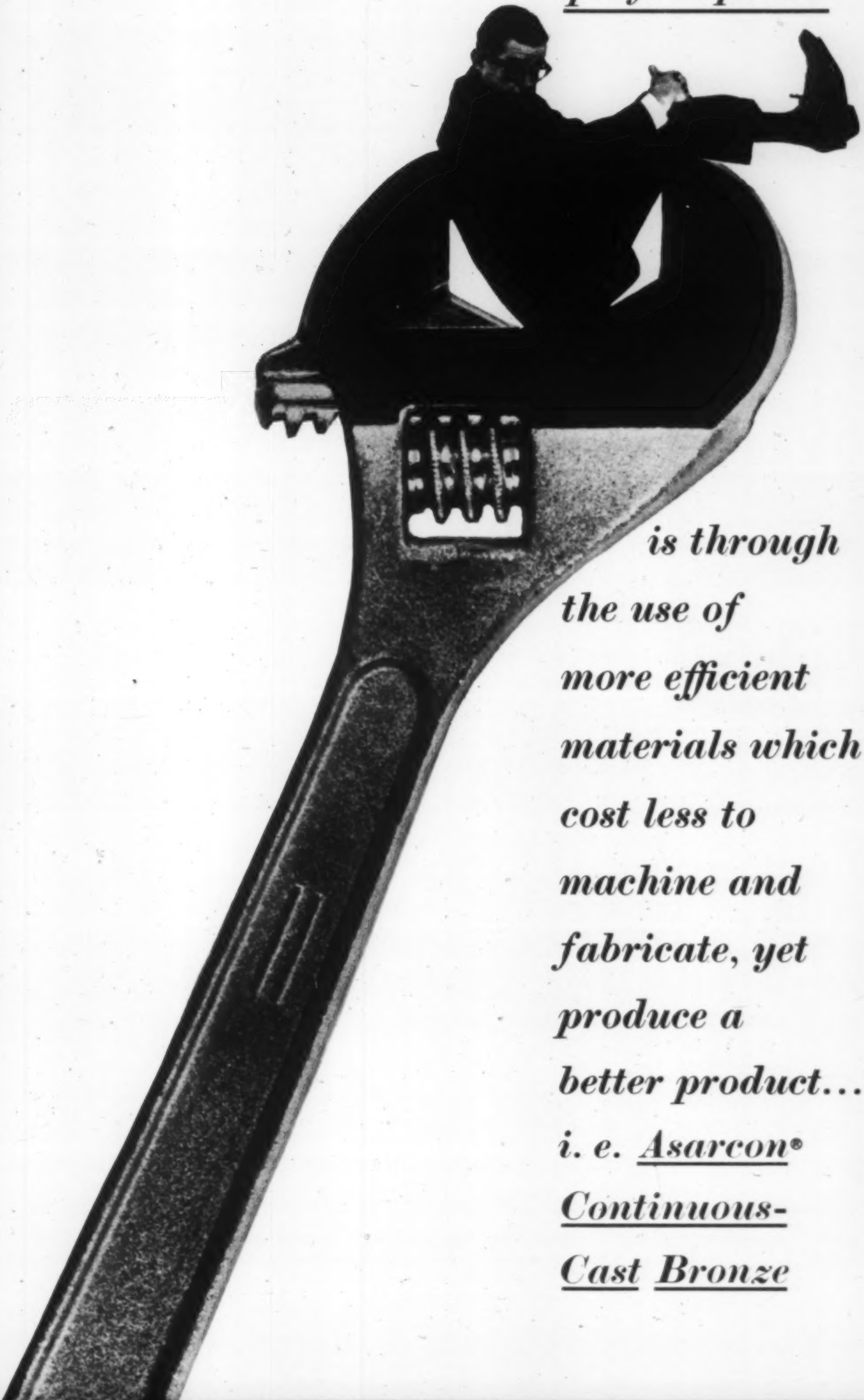
Circle 453 on Page 19→



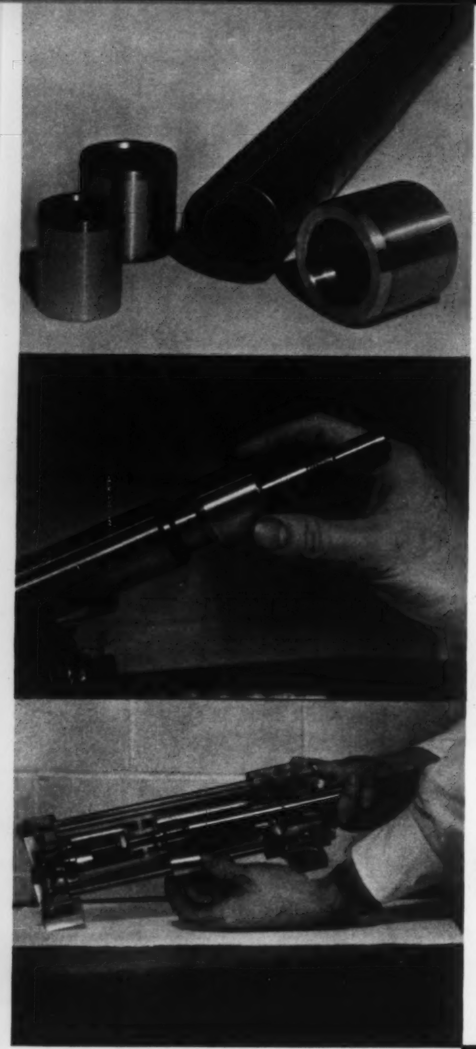
"the fast way out of today's ***profit squeeze***

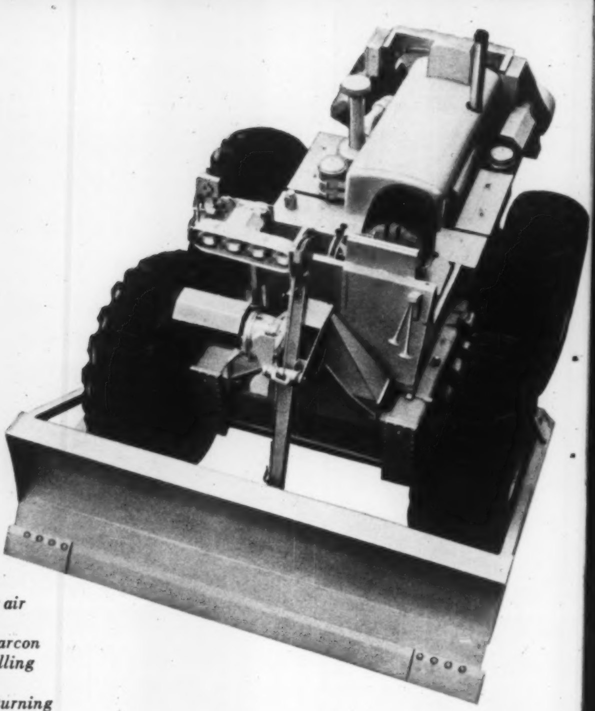
is through the use of more efficient materials which cost less to machine and fabricate, yet produce a better product..."

i. e. ***Asarcon® Continuous-Cast Bronze***

ASARCO

SEE NEXT PAGE





Cushion collars for air cylinders cut from continuous-cast Asarcon tubes eliminate drilling operation, also cut costs of finishing, turning and grinding collars to very close tolerances.

Design for full production efficiency:

Remington Rand
PRINTING CALCULATOR

Motor-drive clutch-ratchet shaft bearings in various Remington Rand calculating machines are continuous-cast from Asarcon 773 Bearing Bronze. These bearings test out 33% higher in impact strength to their sand-cast predecessors!

Easy machining and longer wear governed the choice of Asarcon bronze for the worm gears and guide bushings on this power belt sander.

Asarcon bronze, as power transmission bearings in heavy duty equipment, improves performance, extends service life.

Asarcon bronze bearings act as seal against 3000 pounds of oil pressure in control assembly in Lockheed's C-130. These bearings save space, weight. Their great uniformity gives low friction, high load capacity.

CONTINUOUS-CAST BRONZE CASTINGS

Among the continuous-cast shapes available in Asarcon alloys are those suitable for valve guides, bushings, thrust washers, retainers, gears, brake discs, nozzles, seals, sleeves, plugs.

Lower material costs, faster production, better products. Certainly a powerful set of reasons for evaluating Asarco's unique process of casting shapes in continuous lengths. The alloys produced by continuous casting are in accord with SAE, ASTM, and government specifications but their performance is demonstrably superior to similar alloys cast other ways. So superior in hardness, tensile, yield, and impact strength, that you may be able to substitute an Asarcon bronze for a high-cost aluminum—or manganese bronze. You get the shape you need in the exact lengths you need, with minimum clean-up necessary, machinable on high speed machines.

Before you design or produce a copper base part, investigate the economy and efficiency of continuous-casting. From a simple sketch, Asarco can tell you whether or not your part can be economically made from a continuous-cast alloy. Call in your nearby Asarco representative or write to Continuous-Cast Products Department, American Smelting and Refining Company, Barber, N. J. West Coast Distributor: Kingwell Bros., Ltd., 457 Minna St., San Francisco. In Canada: Federated Metals Canada, Ltd., Toronto and Montreal.

ASARCO

AMERICAN
SMELTING
AND
REFINING
COMPANY

Cut your bearing costs 5 ways with

Asarcon 773 (SAE 660)
Continuous-Cast
Bearing Bronze

260 sizes of rods and tubes. Complete range of sizes from 1/2" to 9" diameters. Immediately available from stock in 105" lengths. Special shapes produced to order.

1. No short-end scrap as from ordinary cast bars. Your Asarcon distributor will cut to requirements. You get *exact* lengths you need. Up to 105".

2. Less diameter loss. Asarcon 773, in a complete range of sizes, comes closer to finished dimensions. Only 1/32" to 3/32" to machine off.

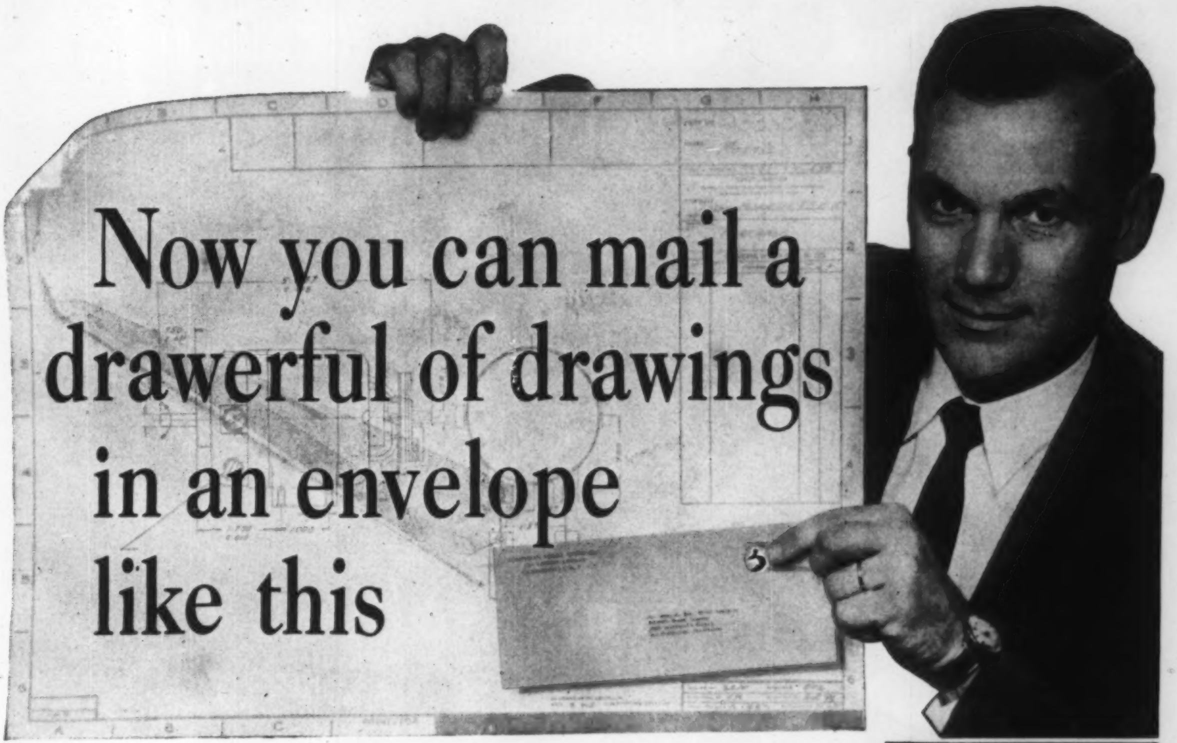
3. Less machining. Less stock to remove means less machining time and cost.

4. No loss of machining time, no parts thrown away because of metal defects. Every casting unconditionally guaranteed to be free of blow holes, pits or shrinks. No sand to dull tools. No hard or soft spots.

5. Less down-time. The better, more uniform properties of Asarcon 773 assure longer life of important machine parts and few breakdowns.

Order Asarcon 773 from stock in 260 sizes, solids and tubes, any length up to 105", from a national network of distributors. Write for address of nearest stock point and complete data, to Continuous-Cast Products Department, American Smelting and Refining Company, Barber, N. J. West Coast Distributor: Kingwell Bros., Ltd., 457 Minna St., San Francisco. In Canada: Federated Metals Canada, Ltd., Toronto and Montreal.

ASARCO

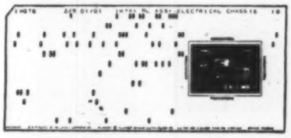


Now you can mail a drawerful of drawings in an envelope like this

Fifty drawings on microfilm cards mailed first class for just 20¢!

New Recordak Precision Engineering Drawing System transforms your bulky drawing files into trim decks of cards—speeds routines and cuts costs in drafting rooms large and small.

Thanks to new Recordak 35mm microfilming techniques and processing controls, drawings and blueprints, regardless of age, size, and color, are reproduced as needle-sharp images with remarkably uniform backgrounds.



Mounting these low-cost and completely accurate 35mm microfilm frames in Filmsort aperture cards gives you an active drawing file which offers many advantages over original paper files.

Cuts copying costs! One user reports this new system cuts need for paper prints 75%. (When needed, handy-size prints can be made.)

Drawings are enlarged sharp and clear in Recordak Reader.

Speeds communications! Another user tells of cutting revision notice time from 6 weeks to 36 hours. Duplicate film cards (for suppliers, contractors, government agencies) cost only pennies apiece, and only pennies to mail!

Speeds reference . . . increases protection! Cards are easy to keep at finger tips, ready for viewing in Recordak Film Reader. Duplicate cards or roll film can be stored off-premises for extra security.

Free booklet gives all the facts on this Recordak System available nation-wide through Recordak branch offices or Recordak Microfilming Dealers.

"Recordak" is a trademark

RECORDAK

(Subsidiary of Eastman Kodak Company)

originator of modern microfilming

—now in its 31st year

MAIL COUPON TODAY

RECORDAK CORPORATION DD-4
415 Madison Avenue, New York 17, N. Y.

Gentlemen: Send free booklet describing new Recordak Engineering Drawing System. No obligation whatsoever.

Name____________________

Company____________________

Title____________________

Address____________________

City__________ State__________

Problem: *"Surface of two parts to be joined must be flush. High fastening torque is required, so maximum head contact and high tensile strength is a must. Fastener must be removable . . ."*

Solution: *HOLO-KROME FLAT HEAD CAP SCREWS. Made of special analysis alloy steel heat-treated to 38-42 Rockwell "C" hardness. Sockets are scientifically proportioned for highest strength and trouble-free driving. Internal hex socket drive assures a smooth, unmarred head. New forging methods result in improved fiber flow, tougher screws. Threads are Unified Class 3A fit.*

For the finest in Hex Socket Screws . . . for unmatched Same-Day Service, the name to remember is Holo-Krome.

HOLO-KROME
SOCKET SCREWS
THE HOLO-KROME SCREW CORPORATION • HARTFORD 10, CONN.

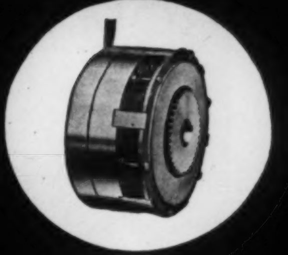
SOLD ONLY THROUGH AUTHORIZED HOLO-KROME DISTRIBUTORS

Circle 455 on Page 19

4 reasons why YOU should use Fawick Magnetics . . .

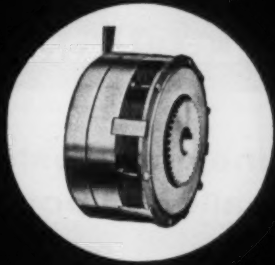
all providing better operation at lower cost!

INSTANT RESPONSE



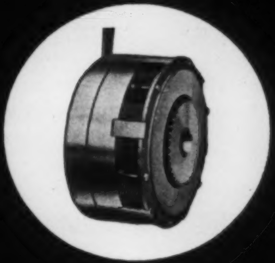
The design features of FAWICK Magnetics provide instant engagement or disengagement of the multiple discs under either wet or dry operation. This permits fast, accurate programming of machine operations from all types of modern electrical or electronic controls.

CONTROLLED TORQUE



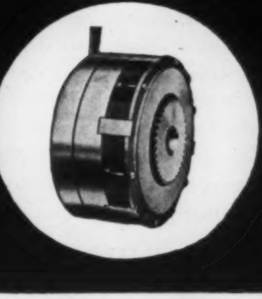
Torque produced by FAWICK Magnetics is easily established and accurately controlled through the FAWICK design which incorporates a straight-line relationship between applied coil voltage and torque output. This permits — in addition to straight starting, running and stopping operations — a wide range of torque-limiting applications.

SMOOTH ACTION



FAWICK Magnetics provide exceptionally smooth, shock-free engagement and disengagement through multiple precision driving and driven discs. Automatic adjustment for normal operating wear insures "new clutch" performance throughout long service life.

COMPACT and COMPLETE



FAWICK Magnetics are supplied "ready for installation" and do not require assembly on the machine. Their high-efficiency performance provides a compact, small size with an excellent torque-vs.-size ratio that is practically adaptable to streamlined machine design.

These basic FAWICK Magnetic advantages are but a few that you can utilize for your machine designs. For full information call or write your nearest FAWICK representative or the Home Office, Cleveland, Ohio.

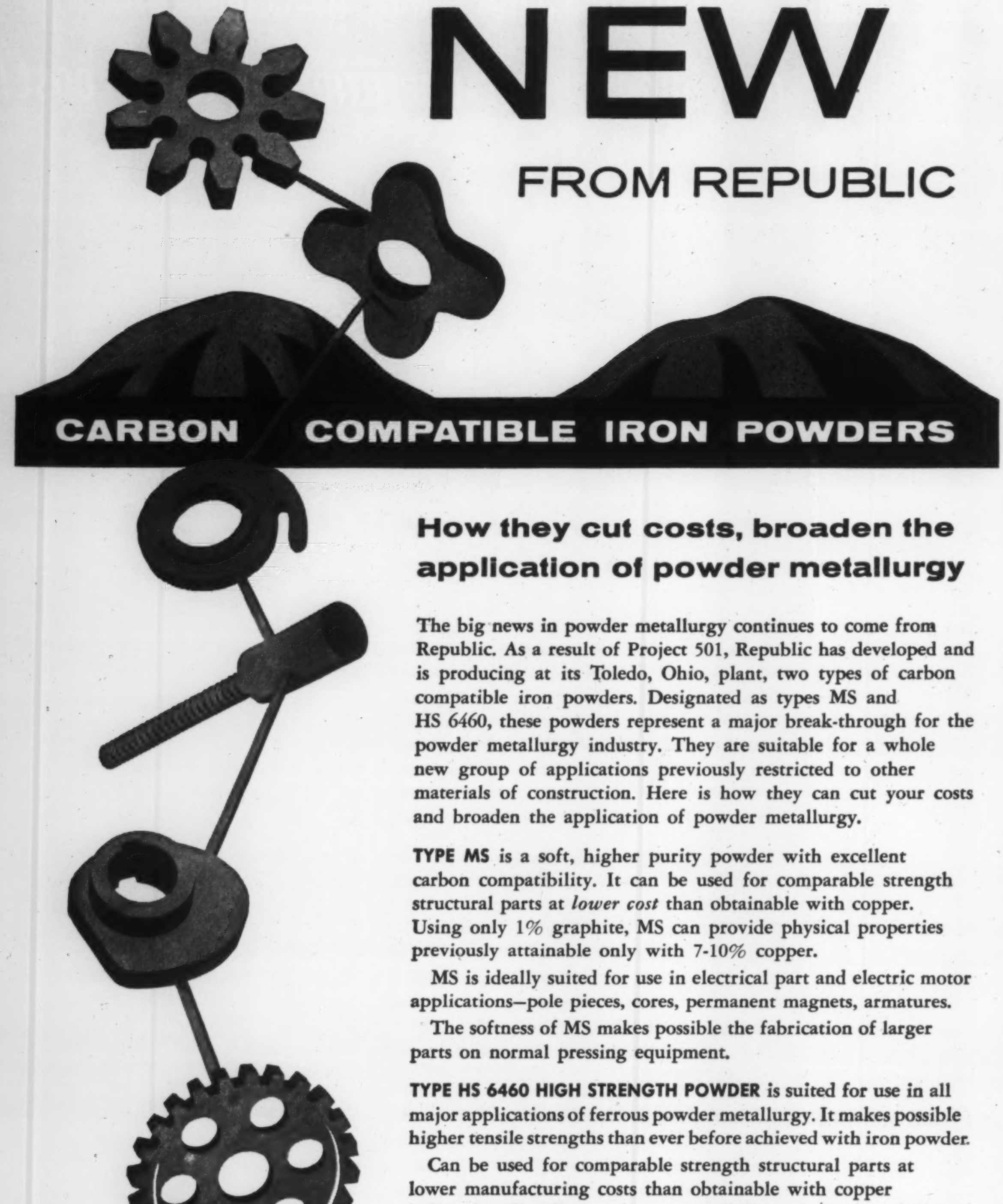
FAWICK AIRFLEX DIVISION
FAWICK CORPORATION
9919 CLINTON ROAD • CLEVELAND 11, OHIO
Fawick Canada, Ltd., 60 Front St., West, Toronto, Ont., Canada

FAWICK
MAGNETIC
INDUSTRIAL CLUTCHES AND BRAKES

Circle 456 on Page 19

NEW

FROM REPUBLIC



CARBON COMPATIBLE IRON POWDERS

How they cut costs, broaden the application of powder metallurgy

The big news in powder metallurgy continues to come from Republic. As a result of Project 501, Republic has developed and is producing at its Toledo, Ohio, plant, two types of carbon compatible iron powders. Designated as types MS and HS 6460, these powders represent a major break-through for the powder metallurgy industry. They are suitable for a whole new group of applications previously restricted to other materials of construction. Here is how they can cut your costs and broaden the application of powder metallurgy.

TYPE MS is a soft, higher purity powder with excellent carbon compatibility. It can be used for comparable strength structural parts at *lower cost* than obtainable with copper. Using only 1% graphite, MS can provide physical properties previously attainable only with 7-10% copper.

MS is ideally suited for use in electrical part and electric motor applications—pole pieces, cores, permanent magnets, armatures.

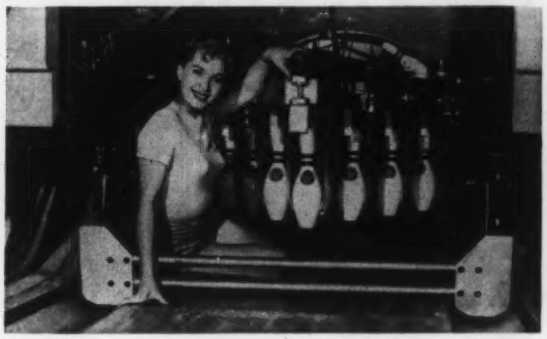
The softness of MS makes possible the fabrication of larger parts on normal pressing equipment.

TYPE HS 6460 HIGH STRENGTH POWDER is suited for use in all major applications of ferrous powder metallurgy. It makes possible higher tensile strengths than ever before achieved with iron powder.

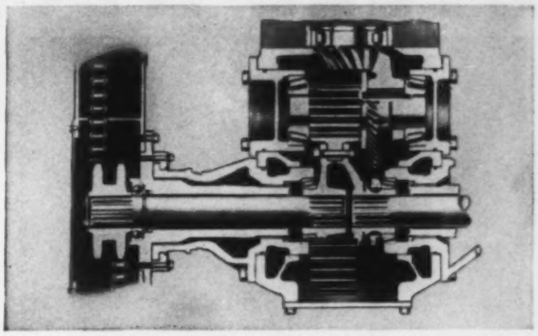
Can be used for comparable strength structural parts at lower manufacturing costs than obtainable with copper infiltration. Excellent carbon compatibility enhances its ability to be heat treated. Additional manufacturing economies can be obtained because fewer operations will be required to obtain high density, higher strength parts.

Our metallurgists and engineers are ready to help you utilize all the advantages of Republic Carbon Compatible Powders. Just mail the coupon to obtain their services, or for technical data sheets on Type MS and Type HS 6460 Powder.

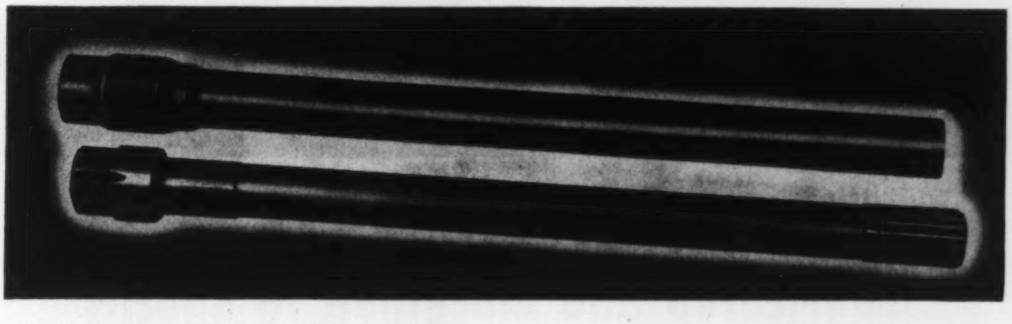
other Republic products for designing and engineering



AMF CUTS COSTS, builds a better pinspotter with Republic ELECTRUNITE® Mechanical Tubing. On the initial order, ELECTRUNITE saved American Machine & Foundry Company, Brooklyn, New York, $34,000 in manufacturing their famous AMF Automatic Pinspotter. AMF was able to eliminate boring and grinding operations because ELECTRUNITE met O.D. tolerance requirements. This feature resulted in a savings of $15,000 in fabricating operations. Another $19,000 was saved on the cost of ELECTRUNITE as compared with tubing previously used. In uniformity, quality, original costs, Republic ELECTRUNITE Mechanical Tubing can save you time and money, too. Call Republic, or mail coupon for facts.



EXCEPTIONALLY HIGH STRENGTH-TO-WEIGHT RATIOS plus resistance to fatigue, stress, shock, and impact are values of Republic Alloy Steels that equipment builders have been relying on for years. Engineers and metallurgists of the Adams Division, LeTourneau-Westinghouse Company, for example, spent thousands of hours on research and testing of all types of steels to find one that would reduce ultimate fatigue to an absolute minimum in the drive axle of their "660" Motor Grader. They selected Republic Hot Rolled 4340 Alloy Steel. This fine steel not only resists fatigue, but also is able to take high torque without a permanent set. Specify Republic Alloy Steels where strength and toughness must resist heavy-duty roughness. Our metallurgists will help you.



NEW FABRICATING PROCESS MEANS ECONOMY. Ford Tractor power take-off counter-shafts cost less to produce using Republic Die-Form blanks, as compared with previous materials. Blank is shown on top . . . completed shaft below. Die-Form is a new method of cold forming hot rolled carbon, alloy, or stainless steel bars into multi-diameter blanks ready for final machining. Since Die-Form blanks closely approximate the completed part, final machining is minimized. Handling costs for raw material and scrap disposal are reduced—production rates increased. Die-Form Process improves machinability of any given steel analysis. Permits further savings through use of higher feeds and speeds. Mail coupon for complete facts.

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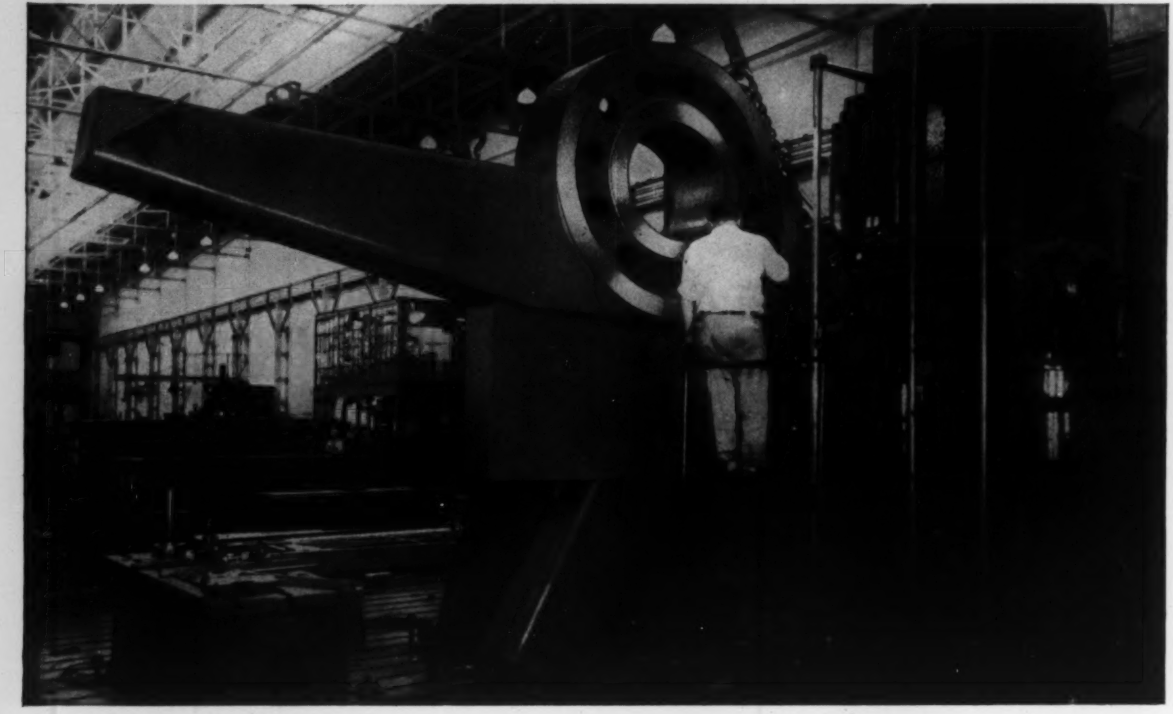
Circle 457 on Page 19

STEEL-WELD FABRICATION . . .



PRECISION WELDMENTS

Fabricated and Machined to Specification!

The 13,000 lb. weldment being machined above is one of 164 Tripods produced and machined by Mahon for use in the world's largest continuous grinding and polishing machine employed in the production of plate glass. The craftsmanship which is immediately apparent in this precision weldment is typical of thousands of Steel-Weld Fabricated parts and assemblies produced year after year by Mahon for manufacturers of processing machinery, machine tools and other types of heavy mechanical equipment.

When you consider weldments of any shape or weight, you, too, will want to discuss your requirements with Mahon engineers—because, in the Mahon Company you will find a unique source for weldments or welded steel in any form . . . a fully responsible source with unusual facilities for design engineering, fabricating, machining and assembling; and a long and enviable performance record in this highly specialized field.

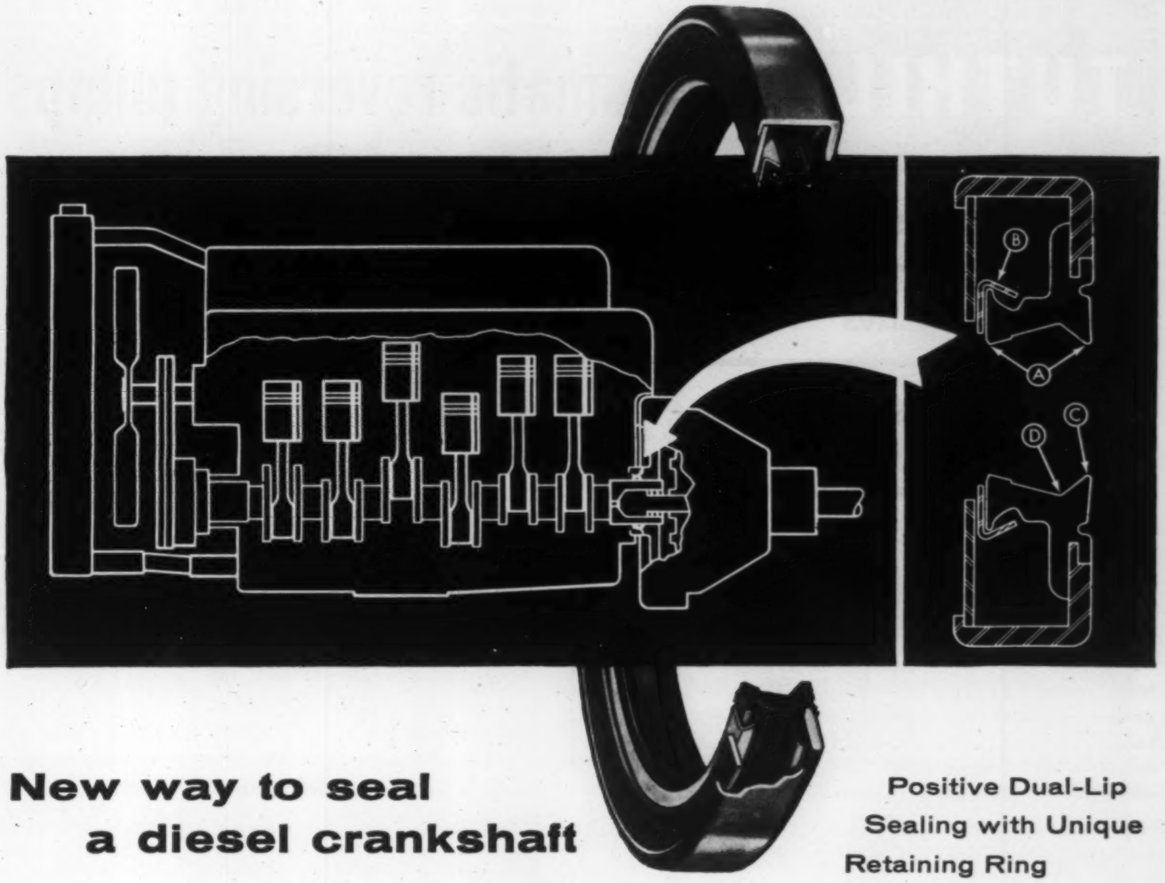
See Sweet's Product Design File for information on Facilities, or have a Mahon sales engineer call at your convenience.

THE R. C. MAHON COMPANY • Detroit 34, Michigan
SALES-ENGINEERING OFFICES in DETROIT, NEW YORK and CHICAGO

Use WELDED STEEL for
100% Predictability
and Greater Strength
with Reduced Weight!

MAHON

Circle 458 on Page 19



New way to seal a diesel crankshaft

Positive Dual-Lip Sealing with Unique Retaining Ring

The tremendous work loads being put on heavy-duty diesels call for a new look at sealing specifications. Stresses on the crankshaft often cause eccentricity with runout as much as .042 in. This makes holding a tight seal at the shaft rear extension with a standard seal design extremely difficult if not impossible. Another consideration is high working temperature—up to 300 deg. F.

Newest provision for this condition on a typical diesel is shown here. This unique yet simple modification of standard Victor oil seal design maintains positive mating of shaft and sealing element under any shaft divergence. The element—a silicone elastomer compounded by Victor—is good to 400 deg. F. intermittently.

In place of the usual garter spring, Victor engineers designed a unique retaining ring, loosely mounted over the sealing lip surface. The ring retains proper lip pressure while it permits the sealing element to follow the exact eccentricities of the shaft.

Have you a shaft sealing problem—or any problem involving oil seals or gaskets? Victor can help you solve it most economically. Contact your Victor Field Engineer or the factory. Victor Mfg. & Gasket Co., P.O. Box 1333, Chicago 90, Ill. Canadian Plant: St. Thomas, Ont.

- **A** Basic design is Victor Type K6 with dual-lip standard construction. Provides maximum fluid retention and exclusion of foreign matter. Sealing element is silicone rubber, integrally molded and bonded to steel case.
- **B** Metal retaining ring loosely mounted over the lip replaces usual garter spring. Allows expansion of element when seal is installed on shaft, yet confines element and retains even lip pressure in operation.
- **C** Outer or secondary lip is molded with very little interference, avoiding danger of turning back lip on installation. When shaft enters primary lip, interference of secondary lip is increased through lever action.
- **D** Lubricant applied between lips before installation permanently lubricates the seal, reduces frictional drag, extends seal life.

A complete reference manual for designers—Victor Oil Seal Engineering Catalog No. 305. Sent on request.

VICTOR

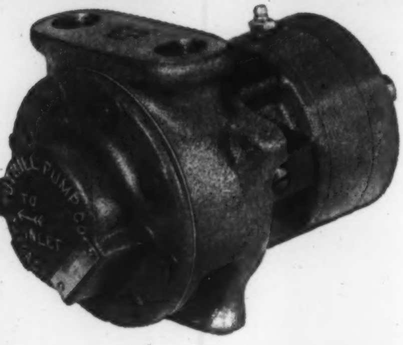
Sealing Products Exclusively

GASKETS • OIL SEALS • PACKINGS • MECHANICAL SEALS

Circle 459 on Page 19

TUTHILL automatic reversing pumps

- **Positive reversing action**
- **Require no valves**
- **Port positions remain constant**



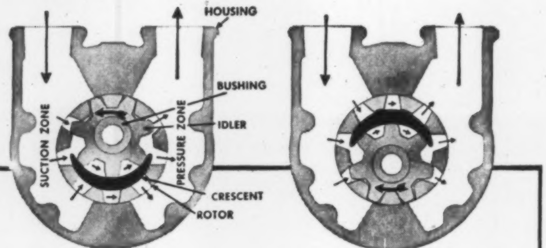
The model RCK above is typical of Tuthill's complete line of automatic reversing pumps . . . which use the time tested operating principle at the right to provide instantaneous, positive reversing action without the use of valves. The port positions remain constant regardless of the direction of shaft rotation. And all pumps provide uniformly high efficiency in both flow directions.

The automatic reversing design was developed by Tuthill for applications where the pump must be driven from a reversing shaft, or where machinery must be shipped without knowing the ultimate direction of the driving unit. These pumps have been enthusiastically accepted by designers and have proven their dependability in thousands of demanding applications such as large air compressors and machine tools.

375 Models

A complete selection of 375 models is provided with capacities from ⅓ to 200 gpm; for pressures to 400 psi; and speeds to 1800 rpm. Included are a complete assortment of stripped models specially developed for incorporation into manufactured products.

A 12-page catalog, No. 105, gives complete information on all Tuthill automatic reversing pumps. Write today for your copy. Or, if you desire, send drawings so that Tuthill's engineers can show you how the Model R reversing pump can be built directly into your product.



COUNTER-CLOCKWISE ROTATION

CLOCKWISE ROTATION

THE PUMPING PRINCIPLE

Tuthill automatic reversing pumps are based on the use of a rotor, idler gear and a crescent shaped partition which is integral with a moving part called the Idler Carrier.

Figure 1 shows how power is applied in counter-clockwise rotation to the rotor and transmitted to the idler gear with which it meshes. The space between the outside diameter of the idler and the inside diameter of the rotor is sealed by the crescent. When the pump is started there is an increase in volume as the teeth come out of mesh. This creates a partial vacuum, drawing the liquid into the pump through the suction port. The liquid fills the spaces between the teeth of the idler and rotor and is carried past the crescent partition to the pressure side of the pump. When the teeth mesh on the pressure side, the liquid is forced from the spaces and out through the discharge port.

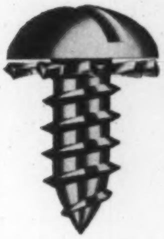
When the shaft rotation changes from counter-clockwise to clockwise, the idler carrier (including the idler gear and crescent) automatically rotates 180° through the suction zone to the position shown in Figure 2 which *changes the direction of flow within the pump* without changing port positions. The idler carrier rotates in a cover casting fitted with stops so that the crescent can rotate only 180°—always through the suction zone. Upon resumption of counter-clockwise rotation, the crescent will swing back to the original position in Figure 1.

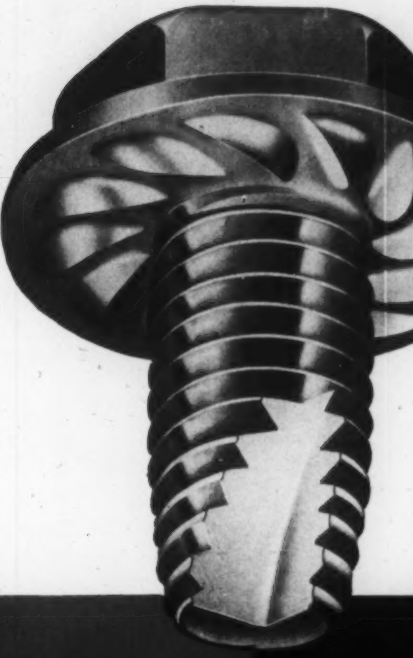
Tuthill Manufactures a Complete Line of Positive Displacement Rotary Pumps in Capacities From ⅓ to 200 GPM; for Pressures to 1500 PSI; speeds to 3600 RPM.

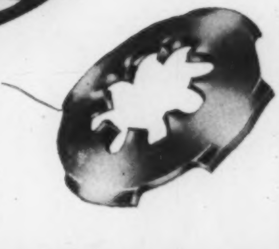
TUTHILL PUMP COMPANY

953 East 95th Street, Chicago 19, Illinois

NFPA

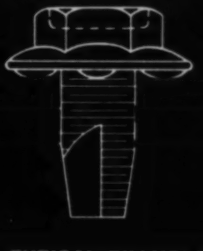






HOW TO SELECT COST-SAVING

fasteners for sheet metal



A TYPICAL EXAMPLE:
How to Avoid Stripping–

When high stripping torques are required, a Shakeproof NIBSCREW® should be used. "Nibs" under the head take up excessive driver torques and eliminate loose screws, re-work and repair.

You can realize important savings on your assembly line by specifying fasteners that eliminate operations, speed up production and assure highest quality. Engineered Fasteners by Shakeproof now overcome stripping, provide sealing, assure maximum locking and solve countless production problems encountered in mass assembly of products using sheet metal.

SEND FOR NEW SHAKEPROOF BULLETIN NO. 1001
Illustrates twelve typical examples of cost saving fasteners for sheet metal applications. Describes important "check points" for fastener selection. Offers testing samples. Write for your copy today!

a guide to
assembly savings
with engineered
fasteners
for Sheet
Metal
applications

SHAKEPROOF DIVISION ILLINOIS TOOL WORKS

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St. Charles Road, Elgin, Illinois
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Division of Canada Illinois Tools Limited, 67 Scarsdale Road, Don Mills, Ontario

Circle 461 on Page 19

BETHCON SHEETS

pass the toughest tests in your shop

You can make snap locks, Pittsburgh lock seams, deep draws, or seamed tubing without damaging either the zinc coating or the steel base of a Bethcon sheet. That's because Bethcon sheets are galvanized by a continuous process which bonds the zinc to the base metal much more tightly than conventional methods.

SPECIAL ANNEALING IMPROVES DUCTILITY

Another advantage of the Bethcon continuous galvanizing process is the remarkable combination of ductility and strength in the sheet, which stems from the special annealing cycle in the continuous line. You'll find a Bethcon sheet neither too soft nor too stiff, but just right for easy workability and a sturdy end-product. The zinc is distributed evenly, so that the finished sheet is uniform in thickness and appearance.

You can specify Bethcon in a wide variety of gages in plain steel or copper-bearing (Beth-Cu-Loy) for extra corrosion-resistance. If you have not yet worked with Bethcon, you might like to talk with someone who has. Or perhaps you'd prefer to discuss it with one of Bethlehem's experienced representatives. You'll get prompt attention by getting in touch with our nearest district sales office.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold
by Bethlehem Pacific Coast Steel Corporation
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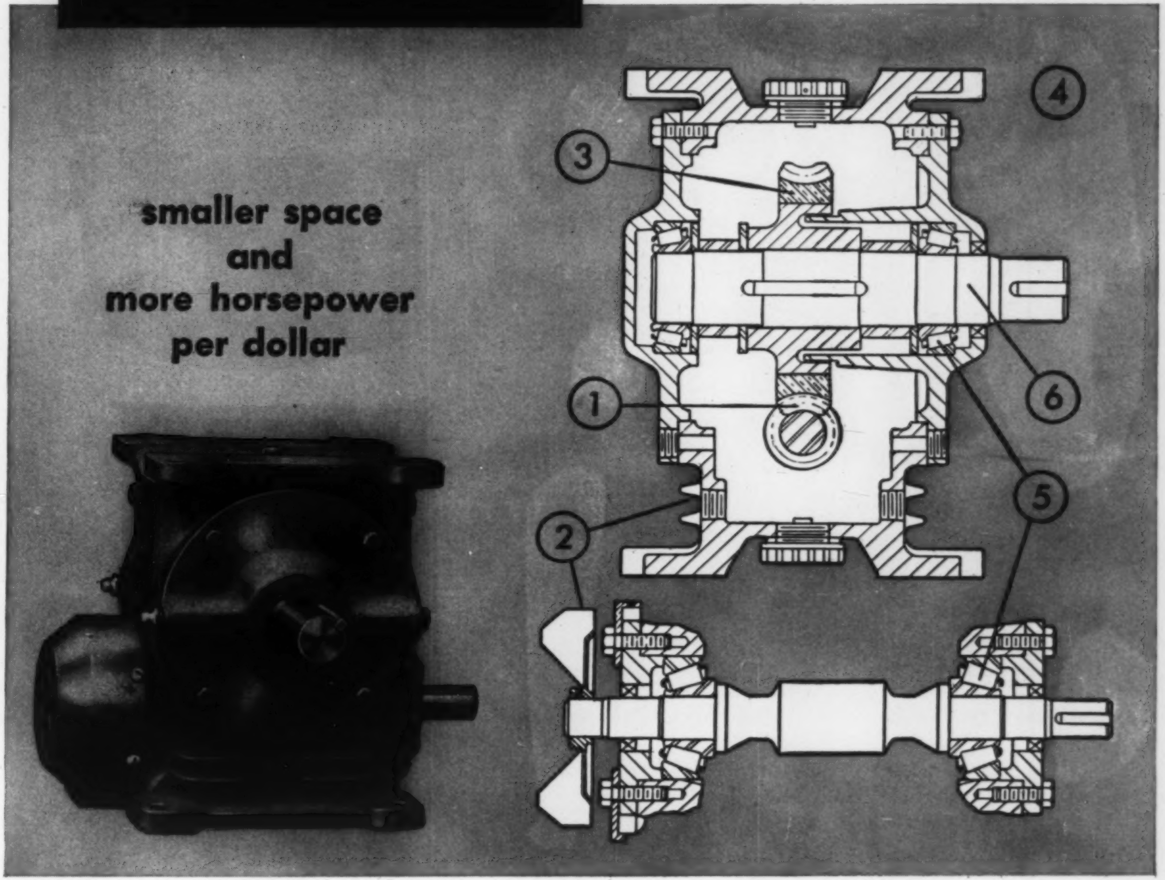
BETHLEHEM STEEL

DELROYD

VERSO WORM GEAR
SPEED REDUCERS

a new standard in worm gear design



Make this value analysis NOW!

1. Involute helicoid thread form has highest load capacity of any type of worm gear.

2. Fan cooling and ribbed construction give maximum effect of heat dissipation.

3. Centrifugally cast bronze dished gear—dry well construction.

4. Unit may be mounted in any position. Alternate mounting surfaces.

5. Tapered roller bearings used throughout—provide maximum load capacity.

6. Heat treated alloy steel gear shaft with bearing and sealing diameters provide a strength of 185% of an untreated shaft of the same diameter.

Send for Catalog No. 5018

DE LAVAL *Steam Turbine Company*

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Solve your motor problems with

You can make your job easier with Century Electric's complete line of fractional-horsepower motors. Here's how:

Easy ordering—You save time because you get answers to all motor problems from one source. This means you don't have to shop around for the motor you need. You name it—capacitor, jet pump, unit heater, oil burner, brake, gear—any one you want, and in all types of enclosures too.

Fast shipments—From Century Electric's complete stock you can get a motor for any standard application. In addition, motors are packed in sturdy boxes so if you reship you know they'll arrive in good condition.

Century's complete fractional line

Application know-how—You want to be sure you have the *right* motor for the job. And if you need expert help, you can get it from your nearest Century Electric sales engineer. He knows motors inside and out because he sells, applies and thinks motors day after day.

This is why you get *more* than just a motor from Century Electric. You get a quality product, fast answers and engineering application know-how on motors up to 400 hp—all from one source.

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St. Louis 3, Missouri *Offices and Stock Points in Principal Cities*

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Circle 464 on Page 19

Relay Frame made by Madison-Kipp for Westinghouse Air Brake Company, Union Switch and Signal Division.

ADDED DESIGN POWER with MADISON-KIPP zinc and aluminum die castings

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The difficult die casting with 2 steel inserts here illustrated was developed and produced with the close cooperation of the user and the die designer.

Please clip this ad as a reminder to contact us when you have die casting requirements.

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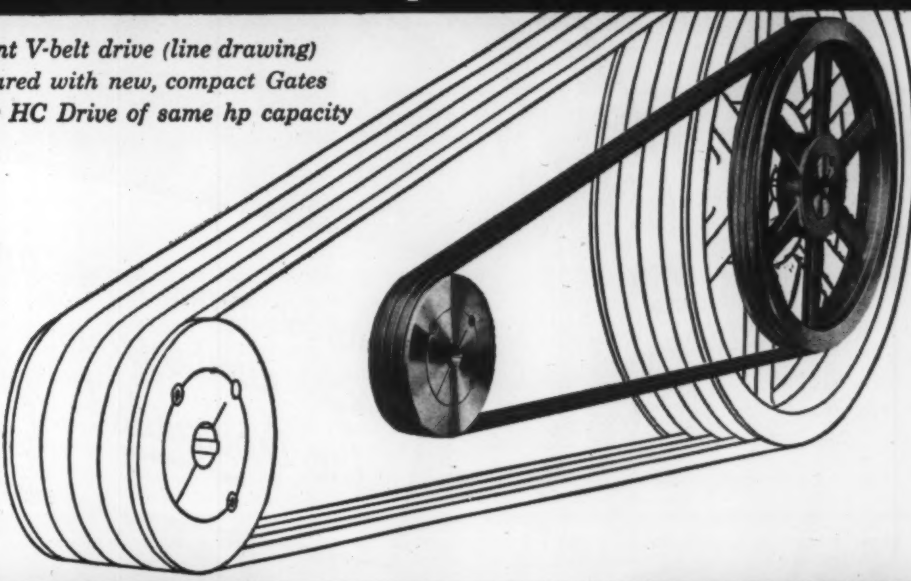
Die Casting Research Foundation Participant

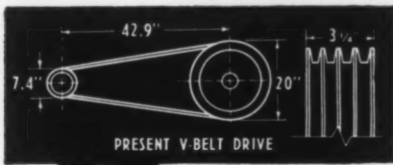
- Skilled in Die Casting Mechanics
- Experienced in Lubrication Engineering
- Originators of Really High Speed Air Tools

Circle 465 on Page 19

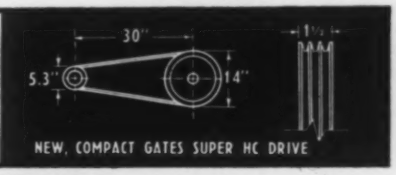
up to 50% LESS SPACE needed for revolutionary new V-belt drive



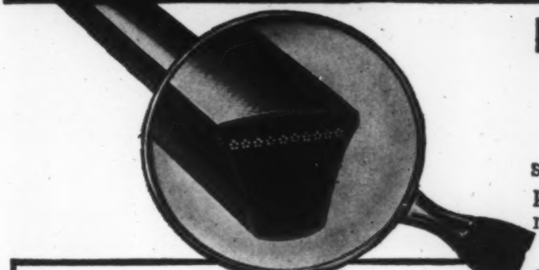
Present V-belt drive (line drawing) compared with new, compact Gates Super HC Drive of same hp capacity



COMPARE: Left, typical drive with present V-belts. Right—drive of same hp capacity with Gates new Super HC V-Belts . . . uses fewer belts, smaller sheaves and shorter center distance.



Reduces drive cost as much as 20%



Exclusive cross-section design: The precisely engineered arched top, concave sidewalls (U. S. Pat. 1813698) and special tensile construction insure full pulling power and longer belt life.

A major advance in the field of power transmission, the fully proved Gates Super HC V-Belt, makes possible the lowest-cost, lightest-weight, most compact multiple V-belt drive that can be put on any machine!

The cost of a new Gates Super HC V-Belt Drive is as much as 20% less than present V-belt drives of the same hp capacity.

For detailed information on the Super HC Drive, contact your nearby Gates distributor or Gates Office for new booklet, "*The Modern Way to Design Multiple V-Belt Drives.*"

TPA 389

The Gates Rubber Company, Denver, Colorado

Gates Rubber of Canada Ltd., Brantford, Ontario

World's Largest Maker of V-Belts

Gates Super HC V-Belt Drives

ROLLWAY
Choose from types and sizes numbered in the thousands!
ROLLWAY MAXIMUM BEARINGS

. . . . . What's the limit: Heat? Shock? Speed? Or complicated radial and thrust loads?

Name the combination of requirements . . . and chances are you'll find them met by a Rollway Maximum precision radial cylindrical roller bearing. If not, then Rollway engineers will modify any factor to meet your application.

Rollers are crowned to prevent end-loading and the resultant spalling of races. Directional trueness is maintained by retainers of standard bronze or "Rollube" ferrous alloy of one piece or two piece construction.

You may wish to refer to the Rollway Catalog and Engineering Data Book when writing specifications for a high precision bearing. It contains the first listing, by any manufacturer, of the thrust capacities of cylindrical radial roller bearings. Send for it today.

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ROLLWAY®
BEARINGS
COMPLETE LINE OF RADIAL AND THRUST CYLINDRICAL ROLLER BEARINGS

Circle 467 on Page 19

ISSUE NO. 12

the neg'ator® sketchbook

The NEG'ATOR® Spring is a new basic mechanical component—a coiled band spring which extends many times its original size without the increasing force common to conventional springs. Used as an extension spring, a motor, band, clamp, or clip, this revolutionary new constant-force component upsets all previous spring principles by doing what springs have never done before.

STOCK NEG'ATOR® MOTORS SOLVE CABLE RETRACTING PROBLEM

How do you keep thick, bulky electrical cables out of the way when drawer-mounted chassis are pushed back into cabinets?

Engineers at Bendix Aviation's Bendix Products Division-Missiles tried bungee cords and counterweights—even considered coiling a long, helical extension spring right into the cable proper. None of these ideas worked satisfactorily. The bungee cords were too bulky and pulled too hard when the chassis was withdrawn. Counterweights avoided the force build-up problem, but were too susceptible to shock and movement. The extension spring idea was found to be impractical.

Not so NEG'ATOR Motors. As shown in Fig. 1, two standard, stock Model A-2025 NEG'ATOR Motors provided an easy, effective solution.

Bendix engineers simply mounted the motors at the bottom-rear of the console cabinet and connected the steel output cord of each motor to the two groups of electrical cables with Teflon lines. Now, when a chassis is returned from its withdrawn position into the cabinet, the NEG'ATOR Motor pulls the cable assemblies back and down into a 3 in. duct at the back of the cabinet.

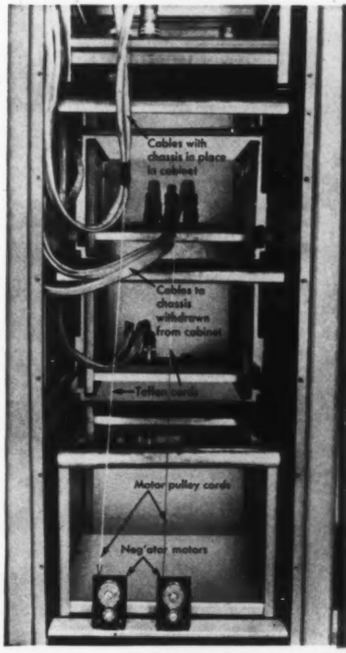

Cables with chassis in place in cabinet
Cables to chassis withdrawn from cabinet
Teflon cords
Motor pulley cords
Neg'ator motors

FIG. 1. Photo shows a Bendix Products Division-Missiles cabinet and drawers with NEG'ATOR Motors in position to retract cables.

This solution to an annoying problem has proved to be effective and economical. The NEG'ATOR Motors came right out of Hunter stock at a cost of $8.00 each. Compact in design, each motor exerts constant 1⅛ lb. tension on the chassis cable. The force varies less than 10% when the motor cord is extended from 0 to 4 ft.

Details on these and other model NEG'ATOR motor assemblies stocked by Hunter are given on the reverse of this sheet.

From the Designer's Sketch Pad

A SIMPLE "MECHANICAL SERVO" SYSTEM

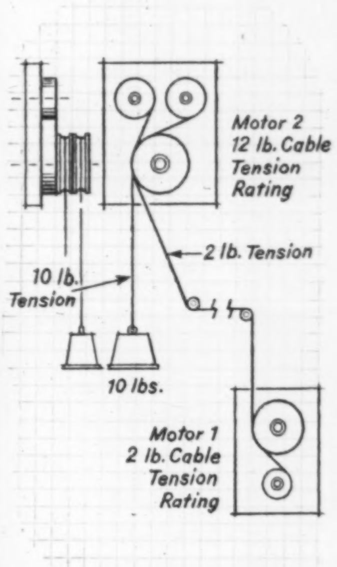


FIG. 2. Two NEG'ATOR Motors can be used to make an inexpensive but practical servo mechanism as illustrated by this diagram. Motor 1 with a 2 lb. cable tension is used as a manually operated actuator. Motor 2 is connected to Motor 1 by means of a common cable, or cord, which runs from the output spool of one motor to the output spool of the other motor. Motor 2, at a remote location, provides a 12 lb. load, 10 lbs. of which support the 10 lb. load while the other 2 lbs. balance Motor 1. Friction keeps the system static until Motor 1 is manipulated. When Motor 1 is operated in either direction, Motor 2 follows. If the only "load" on Motor 2 is an indicating function, both motors can have equal cable tension.

About the NEG'ATOR Sketchbook

If you have previously been on the "SKETCHBOOK" mailing list, we hope that this new method of distribution—through this magazine—will continue to keep you up-to-date. You can still have your copy of each new issue by using the publisher's request card. For copies of previous issues—listed on the reverse page—please write to Hunter direct.

PUBLISHED BY HUNTER SPRING COMPANY • LANSDALE, PENNSYLVANIA

For an additional copy of this sketchbook Circle 468 on Page 19

NEG'ATOR MOTORS SAVE SPACE AND WEIGHT IN AIRCRAFT APPLICATION

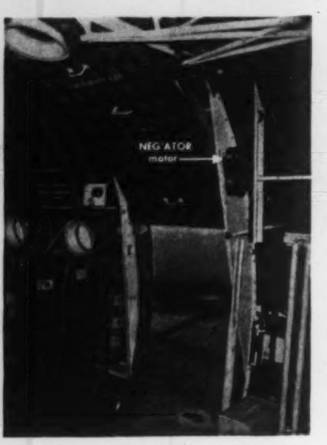


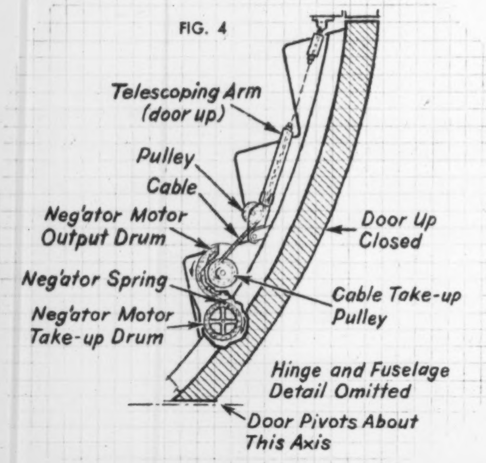
FIG. 3

Dependability, compactness, light weight are three attributes all aircraft designers look for in components. To get these and other important advantages, engineers at the Lockheed Aircraft Corporation, selected constant-force NEG'ATOR Motors to counterbalance the paratroop and crew doors of their large cargo plane.

Two NEG'ATOR Motors (one is visible in Fig. 3) are used to counterbalance the paratroop door which opens vertically and rolls overhead. One motor is mounted on each side of the door frame. Each motor exerts a constant 60 lb. force on the door through a cable and pulley assembly mounted on the motor's output drum. The total force exerted by the two motors helps in lifting the door, holds it in any open position, and prevents its being slammed shut.

The crew door, as shown in Fig. 4, utilizes one NEG'ATOR Motor which is mounted in otherwise waste space under the top step. In this application, the counterbalance cable is wound upon its take-up pulley and the hollow cable arm is telescoped. Lowering the door withdraws the cable, extending the spring, and reverse-wrapping it on the output drum. The torque of the NEG'ATOR spring opposes this action—prevents the door from descending too rapidly, and holds it in place when released. When the door is being closed, the motor rewinds the cable to help lift and close the door.

FIG. 4


Telescoping Arm (door up)
Pulley
Cable
Neg'ator Motor Output Drum
Neg'ator Spring
Neg'ator Motor Take-up Drum
Door Up Closed
Cable Take-up Pulley
Hinge and Fuselage Detail Omitted
Door Pivots About This Axis

STANDARD EXPERIMENTAL NEG'ATOR MOTORS

Originally produced in only two sizes for use as "idea tools" and "demonstrators," standard constant-torque NEG'ATOR Motors are now so widely used that they are stocked in the six models shown in Fig. 5. These motors are specially made—not mass produced. Prices shown are therefore not indicative in any way of the cost of NEG'ATOR springs for motor and other specific, large-volume applications. Orders for stock motors will be shipped immediately. Specifications for all models are given in the table.

Model No.	Spring Torque in Lb.-In.	Cable Tension in Lbs.	No. Revolutions	Cable Length in In.	Endurance (Min. No. Cycles)	Price
P7172	.1	0.375	20	36	3,000	$ 5.00
A2025-1	.78	1.0	15	72	7,500	8.00
A2025-2	1.56	2.0	15	72	2,500	8.00
A2025-3	2.33	3.0	15	72	4,500	12.00
A2025-4	3.12	4.0	15	72	2,500	12.00
A2025-5	3.90	5.0	15	72	2,000	12.00

P7172 Materials: NEG'ATOR Springs—stainless steel; Drums—Nylon; Bases—aluminum; Cable—Nylon.

Materials, all other Models: NEG'ATOR Springs—stainless steel; Drums—Nylon; Bases—Black Synthane; Cable—stainless steel, preformed.

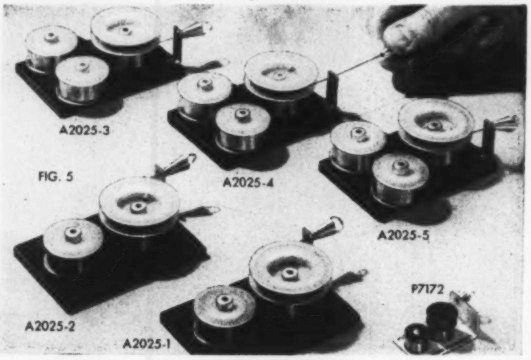


FIG. 5

PREVIOUS SKETCHBOOK ISSUES AVAILABLE ON LETTER REQUEST

Issue 1	The Meaning of Constant Force.
Issue 2	NEG'ATOR Clamps Offer Unusual Characteristics and Applications.
Issue 3	The NEG'ATOR Spring used as a Counterbalance.
Issue 4	The NEG'ATOR Spring Makes an Ideal Long-Running Motor.
Issue 5	NEG'ATOR Spring News Round-Up.
Issue 6	The NEG'ATOR Motor and its Application in Liquid-Level Measuring Devices.
Issue 7	NEG'ATOR Motors Eliminate Extreme Torque Variations, Won't "Skip" Or "Jump."
Issue 8	NEG'ATOR Springs Cover Long Slots and Provide a Movable Aperture.
Issue 10	NEG'ATOR Brush Springs Maintain Constant Pressure, Reduce Wear, Simplify Brush Holder Designs.
Issue 11	NEG'ATOR Springs Counterbalance Without Mass, Simplify Linkages, Save Space.

EXTENSION SPRING

MOTOR

CLAMP

CLIP

HUNTER SPRING COMPANY
A Division of American Machine and Metals, Inc.
29 Spring Avenue, Lansdale, Pennsylvania
SPRINGS • STAMPINGS • QUALITY CONTROL EQUIPMENT

For an additional copy of this sketchbook Circle 460 on Page 19 Printed in U.S.A.

TOTAL COVERAGE

No matter which way the wind blows with your blower unit requirements—belt-driven, direct drive or radial-axial mixed flow—Torrington has the solution to your problems.

This means complete technical data and the proved-out performance rating on three lines of basic blower unit designs.

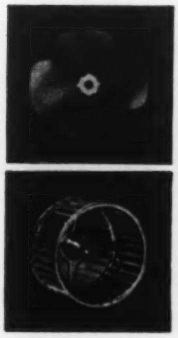
In addition to the standard direct drive units and the already famous VariBasic belt driven series, latest and most spectacular addition is the exclusive Radiax unit, combining the optimum performance characteristics of both radial and axial flow techniques.

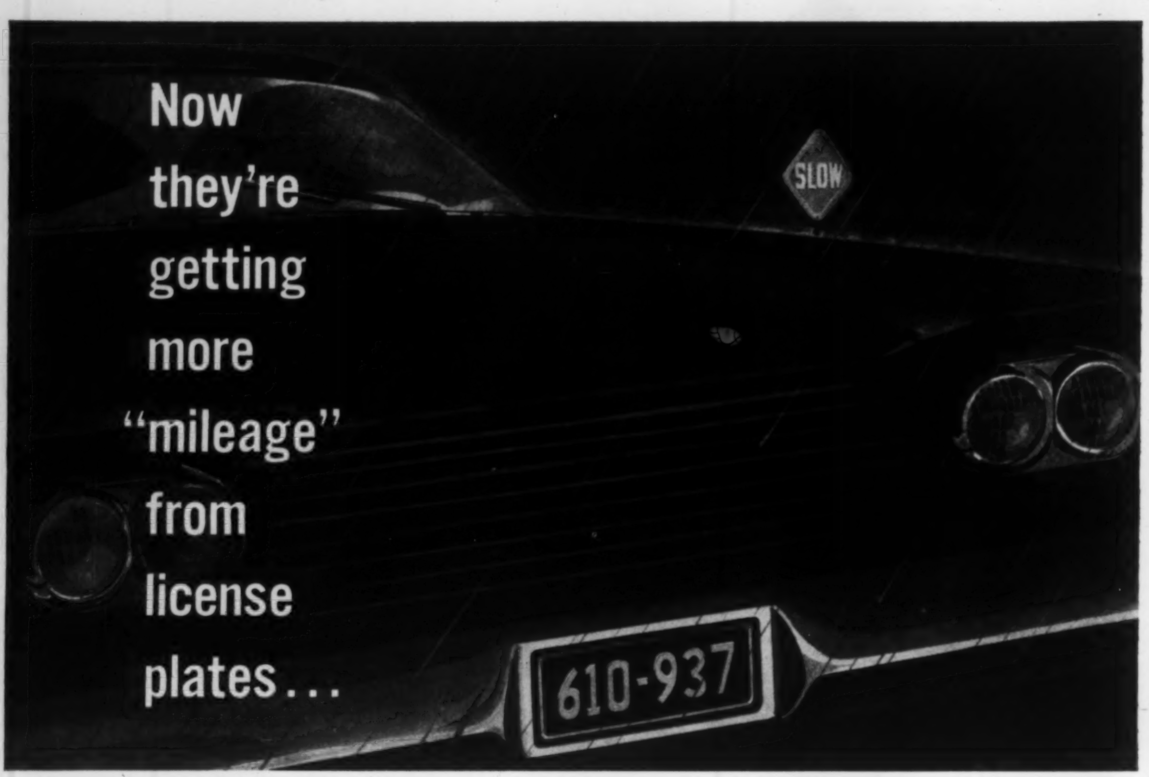
The result is FULL COVERAGE—the best "problem insurance" you could have.
Talk to Torrington!

THE TORRINGTON MANUFACTURING COMPANY

TORRINGTON, CONNECTICUT • VAN NUYS, CALIFORNIA • OAKVILLE, ONTARIO

Circle 469 on Page 19





...Alodized with ALODINE!

Increased use of the five year aluminum license plate makes it vitally important that the metal retain its durability and wearing qualities under severe conditions of highway usage.

A number of forward looking states have already specified Amchem Alodine as the preferred prepaint treatment of aluminum license plate blanks. Amchem Alodine forms an amorphous coating on aluminum, insures its corrosion resistance and guarantees a tenacious bond for paint. It is simple to use, low in cost and highly efficient in its protective nature.

Whatever your metalworking problems, you can depend on Amchem Alodine and a host of associated chemicals and processes to facilitate production and provide you with a better product.

States now specifying Amchem Alodine for protective treatment of license plates, traffic signs, highway markers, etc.

DISTRICT OF COLUMBIA
INDIANA
KANSAS
MISSISSIPPI
MISSOURI
NEBRASKA
NEW HAMPSHIRE
NEW JERSEY
NEW YORK
PENNSYLVANIA
VIRGINIA
WISCONSIN
MONTANA
OREGON

Write for Bulletin 1424A describing specific applications of Amchem Alodine. Contains handy selection chart to help you choose the Alodine type suited to your needs.

AMCHEM

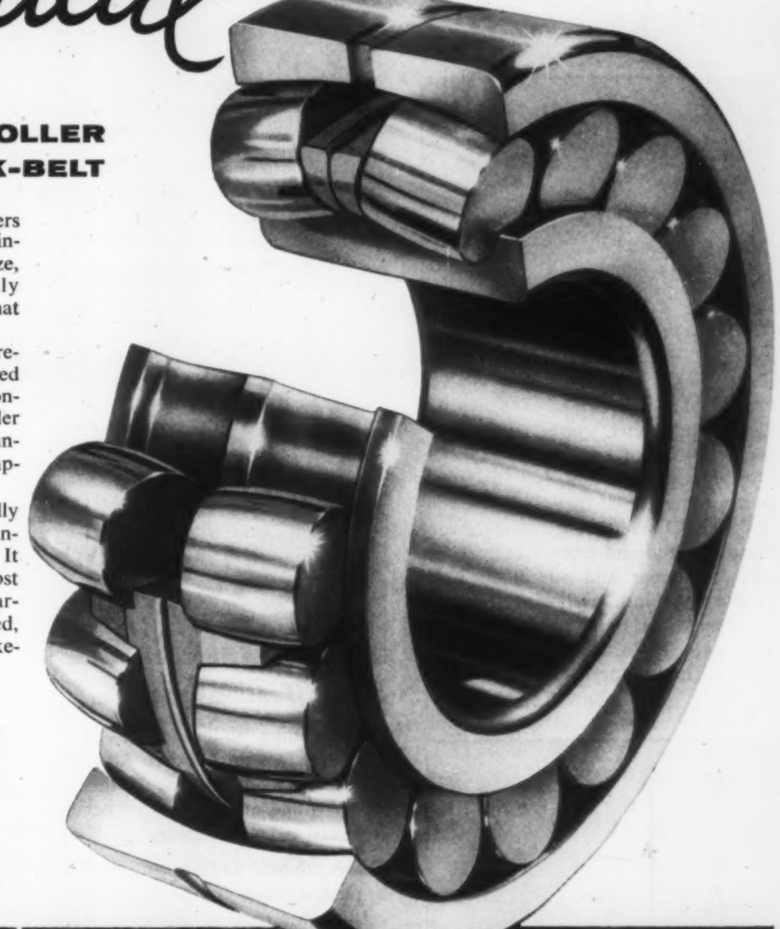
ALODINE

Alodine is another chemical development of **Amchem Products, Inc.** (Formerly American Chemical Paint Co.) Detroit, Mich. • St. Joseph, Mo. • AMBLER 18, PA. • Niles, Calif. • Windsor, Ont. / Amchem and Alodine are registered trademarks of Amchem Products, Inc.

News! The best features of modern bearing design combined and refined in

Spherical

SELF-ALIGNING ROLLER BEARINGS BY LINK-BELT



BIG, mirror-smooth convex rollers *plus* heavy, broad-shouldered inner race *plus* centrifugally-cast bronze, precision-machined retainers! Only from Link-Belt do you get ALL that is best in modern bearing design.

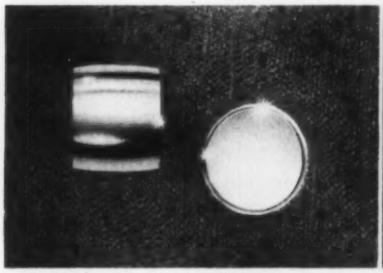
Individually, these elements represent major improvements on accepted design concepts. Collectively, they constitute the most efficient spherical roller bearings available . . . promise unequalled economies, whatever the application.

Your Link-Belt office will gladly explain the many performance advantages evolved with this new design. It can furnish full data on industry's most complete line of ball and roller bearings . . . pillow blocks and flanged, flanged-cartridge, cartridge, and take-up blocks.

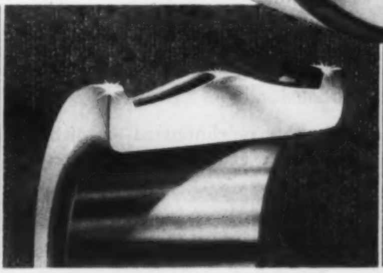
LINK-BELT

MANUFACTURERS OF SELF-ALIGNING BALL AND ROLLER BEARINGS

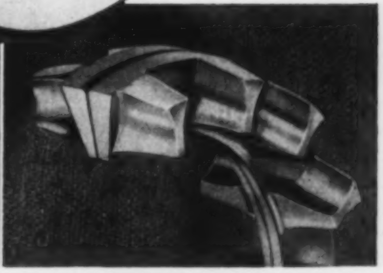
LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. Plants, Sales Offices and Distributors in All Principal Cities. 14,819-A



BIG, HIGHEST-CAPACITY ROLLERS. Each bearing has a maximum number of rollers—as large as possible, yet all components are in optimum balance.



HIGH, HEAVY INNER RACE FLANGES present convenient hold for assembly and removal of bearing without cutting away shaft, avoid any need to skimp on shaft shoulders.

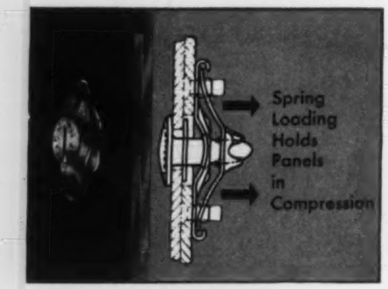


PRECISION-MACHINED, CENTRIFUGALLY-CAST BRONZE RETAINERS have many times more support and ability to withstand high stress. They are not stampings. Design assures maximum bearing efficiency.

Quick-Opening Fasteners

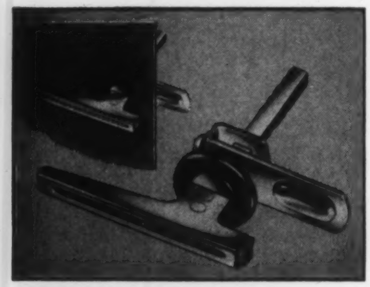
Selecting Small Fastenings for Metal Closures

> *"Use captive fasteners wherever feasible . . . Avoid the use of loose washers and loose nuts . . . Fasteners on equipment covers should be operable either with no tools or with standard hand tools"**
>
> *(John D. Folley, Jr. & James W. Altman, Research Scientists, American Institute for Research)*



Quarter-Turn Fastener

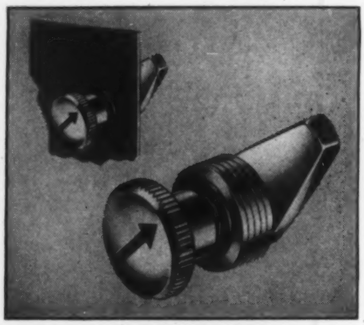
Lion Fasteners open and close with a ¼ turn, hold sheets tightly under the compression of a rugged spring. Quickly operated and fully retained in the outer panel, they are approved under U. S. Government military specifications. Stud and receptacle float for easy alignment and simplified hole preparation. Flush, oval, wing, knurled, ring, and key head styles available. Sizes—No. 2, No. 5, and High Strength for extra heavy duty.



Cabinet Latch

Just drill a hole, push the fastener stem through, and slide the special push-on clip into place. No welds, screws, bolts or rivets: the fastener is permanently installed in seconds!

Adjustable to any grip length or panel thickness, the pawl is fixed in place by a single set screw. The fastener's brightly finished knob is set off by a plated washer. Also furnished with screwdriver operated flush head.

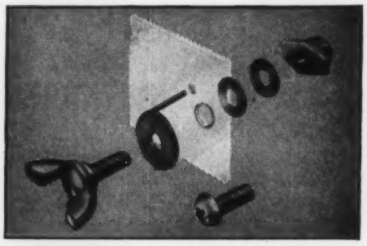


Spring Tension Latch

For fastening slide-out drawers and hinged panels the Southco Arrowhead Latch is recommended. It locks or opens with a quarter turn yet occupies less than ½" inside space.

Doors are held under spring tension—a push against the arrowhead knob relaxes this tension, allows operation with fingertip ease. Drill a single hole for installation—no fastening to the door is necessary No striker plate is needed.

Pawl stop is eliminated—arrowhead shows at a glance exact position of pawl.



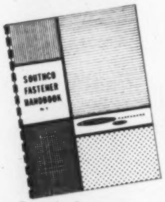
Adjustable Panel Latch

Small doors and panels can be fastened with greatest speed and lowest cost with the Southco Adjustable Latch.

The entire fastener is quickly installed through two holes punched in the door; no bolts or rivets are needed.

It operates with a quarter turn, requires no striker plate. An extra twist after the nylon pawl is engaged pulls up the door to form a seal and eliminate vibration.

Available with wing, knurled, or Phillips head.



Free Fastener Handbook

Send for your free copy of Fastener Handbook No. 9, just released. Gives complete engineering data on these and many other special fasteners. Forty-eight pages, in two colors.
Write on your letterhead to Southco Division, South Chester Corporation, 237 Industrial Highway, Lester, Pa.

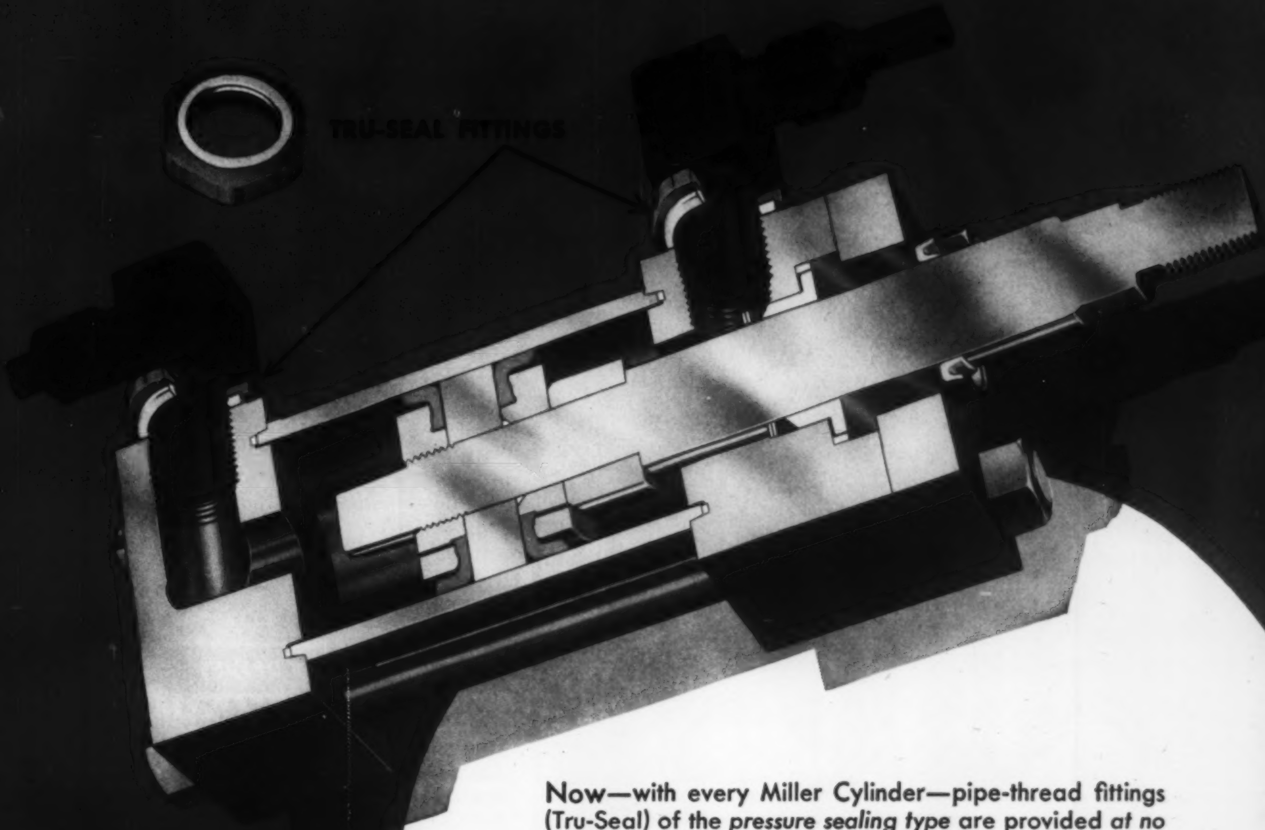
SOUTHCO / FASTENERS
LION

©1956

*** *Quotation from "Designing Electronic Equipment for Maintainability"; Machine Design, July 12, 1956.***

NOW...even the PORTS have seals of the PRESSURE SEALING TYPE!

(J.I.C. Standard H6.2.2)



Now—with every Miller Cylinder—pipe-thread fittings (Tru-Seal) of the *pressure sealing type* are provided *at no extra cost* for sealing the cylinder ports.

Additional advantages of these fittings are:

1. All circuit piping and fittings can be easily positioned.
2. Damage to equipment caused by high tightening torque is completely eliminated (especially on valves, pumps, etc.)
3. Sealing material is Teflon, which is compatible with all hydraulic fluids (J. I. C. Standard H6.2.1)

Specify

Miller

for

Greater Reliability

HYDRAULIC CYLINDERS

Engineering Bulletins
on Miller Air and Hydraulic Cylinders
Available on Request

MILLER FLUID POWER
DIVISION OF FLICK-REEDY CORPORATION

2006 N. HAWTHORNE, MELROSE PARK, ILL.

AIR AND HYDRAULIC CYLINDERS • ACCUMULATORS
COUNTERBALANCE CYLINDERS • BOOSTERS

Circle 473 on Page 19

Handle Any Adjustable-Speed Job with One of these Square D "packages"*

One of 13 ***CUSTOM DRIVES*** *for an automotive plant for control of 6 miles of monorail conveyors*

** a Square D "package" includes the power conversion unit, operator's station, and drive motor*

ELECTRONIC DRIVES

employ advanced designs using more static elements and less tubes. Fail-safe circuits prevent motor runaways. Available in sizes from 1/20 H.P. through 40 H.P.

STATIC POWER MAGNETIC AMPLIFIER DRIVES

provide top reliability and simple maintenance. Save both floor space and weight as compared to conventional drives. Available in sizes through 400 H.P.

MOTOR-GENERATOR DRIVES

use static regulators and rectifiers for simplified maintenance. Rugged, heavy-duty components are provided in each drive. Available in sizes through 400 H.P.

CUSTOM DRIVES

for every possible adjustable-speed requirement can be designed for you using combinations of the above units, plus special units, with accuracies to fractions of 1%. The answer to your adjustable speed problem is as near as your Square D field office.

No matter what adjustable-speed requirements you may have, you can select a Square D drive to meet them exactly. Moreover, every component—from control to drive motor—is subjected to a complete electrical test, and the entire drive is test-run at the factory to assure top performance on the job.

Write **for complete details. Ask for Adjustable-Speed Bulletin.**
Square D Company, 4041 North Richards St., Milwaukee 12, Wis.

EC&M HEAVY INDUSTRY ELECTRICAL EQUIPMENT...NOW A PART OF THE SQUARE D LINE

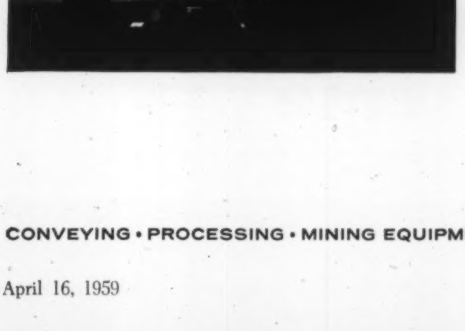
SQUARE D COMPANY

Circle 474 on Page 19

Bill St. John (left) with Heltzel Chief Engineer, W. J. Kirchner, who said: "As a result of Bill's recommendation, we're using Jeffrey's combination chain. It's economical, yet gives the needed strength in our higher elevators."

"Jeffrey gives us the kind of service we want"

Heltzel buyer, John Holodnak (right): "It's strictly service as far as Jeffrey is concerned with us. Jeffrey gives us quotations in two days or less. They stock for us. Delivery is no problem."



The Heltzel Steel Form & Iron Company, of Warren, Ohio, manufacturer of concrete batching plants, now looks to Jeffrey for power transmission components. Heltzel engineers and buyers agree that Jeffrey gives them the kind of service they want.

Commenting on Jeffrey service, Heltzel Chief Engineer, W. J. Kirchner stated, "Originally, Jeffrey's Director of Research came to Heltzel with Bill St. John (Jeffrey Northeast Ohio Sales Engineer). They sat down and discussed our needs – Bill knows what he's talking about. We understand each other. We have followed his recommendations in many instances."

Find out exactly how Jeffrey delivers the kind of service you ought to have. Arrange a meeting through the Jeffrey office nearest you, or contact: Manager, OEM Sales, The Jeffrey Manufacturing Company, 798 North Fourth Street, Columbus 16, Ohio.

JEFFREY

CONVEYING • PROCESSING • MINING EQUIPMENT...TRANSMISSION MACHINERY...CONTRACT MANUFACTURING

Circle 475 on Page 19

Almost Anyone Can Make Solenoid Parts, But...

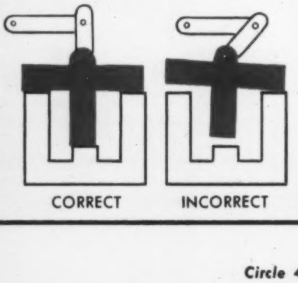
Headache-Free Solenoid Application Takes Machine Tool Precision

There may be solenoid application problems that we can't solve, but . . . we have yet to find one. It's simply because we are machine tool builders and fully understand the basic problems of converting electrical energy to mechanical energy. We've been at it for over 70 years. It's the reason why Namco solenoids have superior electrical and mechanical characteristics and why we can assure you of the one other factor that *truly* determines solenoid life...*proper application*.

Namco standard solenoids are available in a wide range of push and pull types. Custom-engineered solenoids in every size, capacity and type can be made to meet your specifications. Write us about *your* application problems stating specific requirements.

For Example:

Operating in an arc without proper linkage will cause incorrect seating of the plunger . . . allowing the solenoid to draw partial inrush current continuously. This will cause overheating and eventual malfunction of the solenoid.

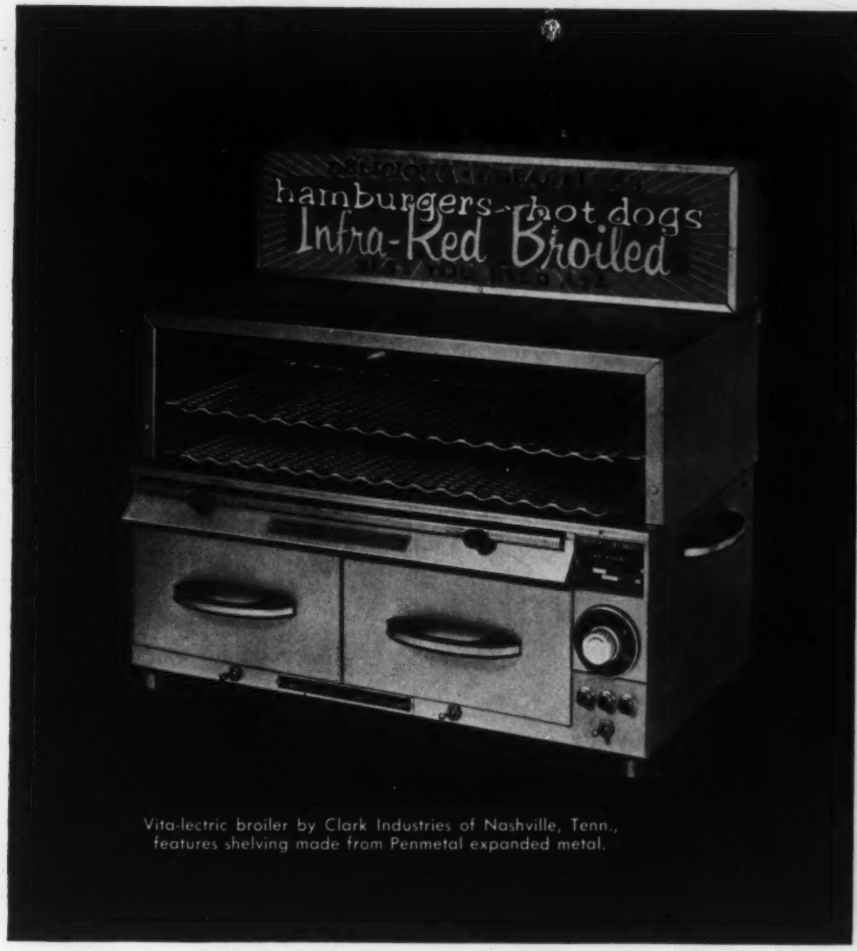


National Acme

The National
Acme Company
188 E. 131st Street
Cleveland 8, Ohio

Sales Offices: Newark 2, N.J.; Chicago 6, Ill.; Detroit 27, Mich.

Circle 476 on Page 19



Vita-lectric broiler by Clark Industries of Nashville, Tenn., features shelving made from Penmetal expanded metal.

HANDSOME, HARDY SHELVING

still another use for Penmetal expanded metal

To appreciate why Penmetal expanded metal is becoming more and more popular with designers, note the advantages gained from its use as shelving for the Clark Vita-lectric broiler.

Grease and food particles are easily removed from the *flattened* expanded metal with nothing more than a spatula. Complete cleaning can be accomplished with warm water and soap. The open diamond mesh stands up under heat and heavy use—imparts a smartness that cannot be denied. Cost: Surprisingly little.

Comes in flattened or standard form; in carbon steel, aluminum, stainless steel or other corrosion-resistant metals; large or small mesh; light or heavy gauge. Readily cut, shaped and welded.

Send for catalog 515-EM, which describes Penmetal expanded metal in detail, and suggests a number of ways you might use this versatile material.

PENN METAL COMPANY, INC.

General Sales Office:
40 Central St., Boston 9, Mass.
Plant: Parkersburg, W. Va.
District Sales Offices: Boston, New York, Philadelphia, Pittsburgh, Chicago, Detroit, Dallas, Little Rock, Seattle, San Francisco, Los Angeles, Parkersburg

Infra-Red Broiled

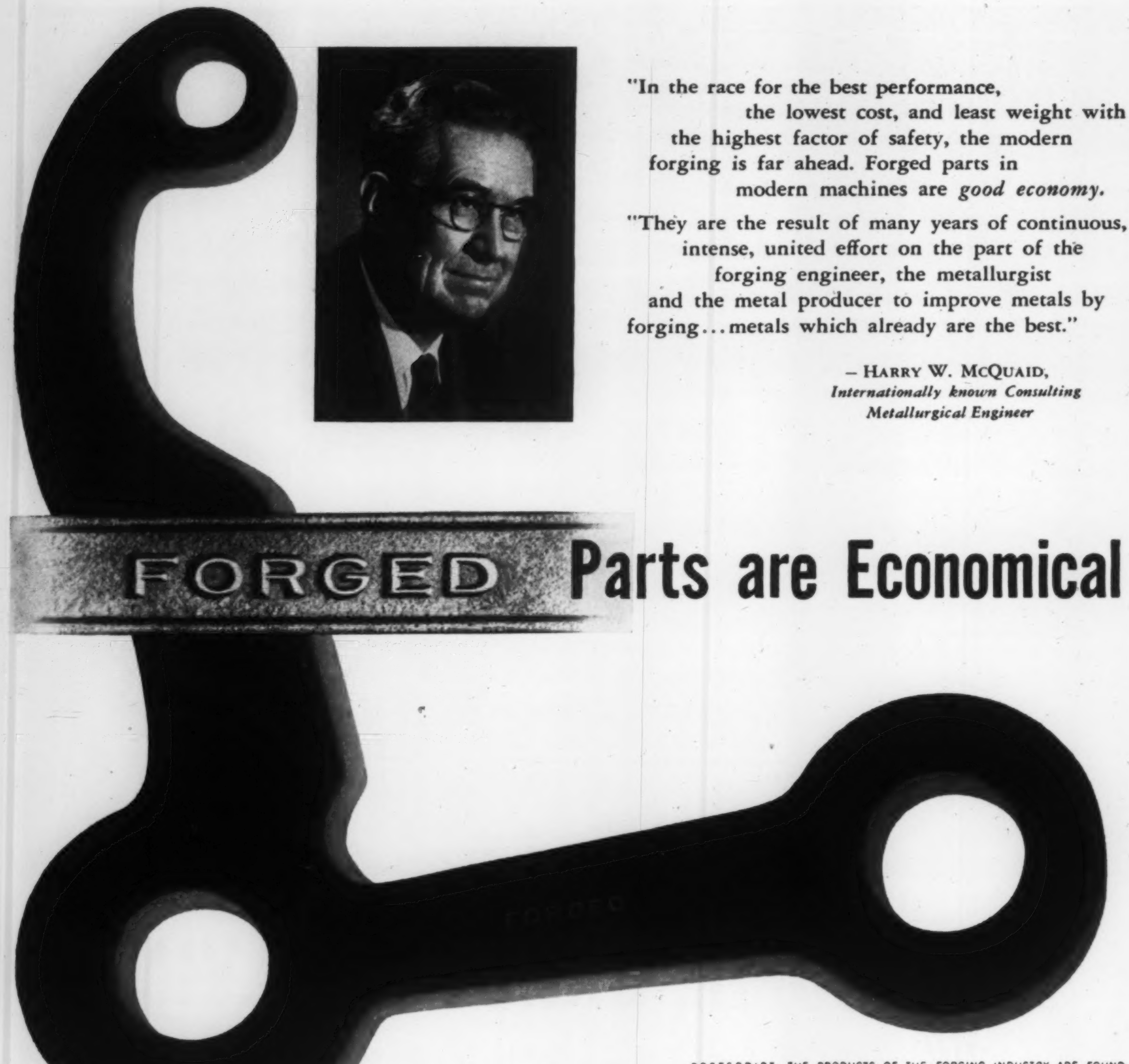
Expanded metal is used in the broiler drawers, too.

Penmetal
1869

a name to remember

PM-201

Circle 477 on Page 19



"In the race for the best performance, the lowest cost, and least weight with the highest factor of safety, the modern forging is far ahead. Forged parts in modern machines are *good economy.*

"They are the result of many years of continuous, intense, united effort on the part of the forging engineer, the metallurgist and the metal producer to improve metals by forging... metals which already are the best."

– HARRY W. MCQUAID,
Internationally known Consulting Metallurgical Engineer

Parts are Economical

POSTSCRIPT: THE PRODUCTS OF THE FORGING INDUSTRY ARE FOUND AT VITAL POINTS OF MODERN CONVEYANCES AND MACHINES... LEVERS, STRUTS, CRANKSHAFTS, GEARS. THE FORGING PROCESS IS UNLIKE ANY OTHER. *FORGED* PARTS START WITH REFINED METALS—METALS ALREADY TRIED AND PROVED. THESE METALS ARE GIVEN ALMOST ANY DESIRED FORM OR SHAPE BETWEEN IMPRESSION DIES, UNDER ENORMOUS PRESSURE OR BY CONSECUTIVE BLOWS FROM POWERFUL HAMMERS. THE RESULT IS ADDED STRENGTH AND TOUGHNESS... WHICH PERMITS WEIGHT-SAVING DESIGNS, CUTS SERVICE COSTS, HELPS PROVIDE SAFETY IN A HIGH-SPEED WORLD.

DROP FORGING ASSOCIATION 55 Public Square • Cleveland 13, Ohio

MEMBERS: THE ALLIANCE DROP FORGING CO. • AMFORGE DIVISION, AMERICAN BRAKE SHOE COMPANY • THE ASHTABULA BOW SOCKET CO. • THE ATWATER MFG. CO. • BALDT ANCHOR, CHAIN & FORGE DIVISION, THE BOSTON METALS COMPANY • THE BILLINGS & SPENCER CO. • BONNEY FORGE & TOOL WORKS • THE BREWER-TITCHENER CORP. • THE BRODERICK CO. • BUCHANAN STEEL PRODUCTS CORP. • CALIFORNIA DROP FORGE CO. • THE CANTON DROP FORGING & MFG. CO. • CAPE ANN TOOL CO. • THE E. D. CLAPP MFG. CO. • CLIFFORD-JACOBS FORGING CO. • COLUMBUS BOLT & FORGING CO. • THE COLUMBUS FORGE & IRON CO. • COLUMBUS IRON WORKS CO. • COMMERCIAL SHEARING & STAMPING, INC. • CORNELL FORGE CO. • DOMINION FORGE LIMITED • THE DROP DIES & FORGINGS CO. • DUFF-NORTON CO. • ENDICOTT FORGING & MANUFACTURING COMPANY, INC. • ENGLUND FORGE COMPANY • FEDERAL DROP FORGE COMPANY • A. FINKL & SONS COMPANY • FORGINGS & STAMPINGS, INC. • GENERAL METALS CORPORATION • GIANT GRIP MFG. CO. • THE HARRIS-THOMAS DROP FORGE CO. • H. E. HOLBROOK DROP FORGE, INC. • HURON FORGE & MACHINE CO. • INDIANA FORGE & MACHINE CO. • INDIANAPOLIS DROP FORGING CO., INC. • INTERSTATE DROP FORGE CO. • JOOST MANUFACTURING CO. • KEYSTONE FORGING CO. • KORTICK MANUFACTURING CO. • KRAEUTER & COMPANY, INC. • KROPP FORGE CO. • LADISH CO. • LAKEVIEW FORGE CO. • THE THOMAS LAUGHLIN DIVISION, AMERICAN HOIST & DERRICK CO. • LEBUS MANUFACTURING CO. • MERRILL BROTHERS • MICHIGAN FORGING CO. • MILWAUKEE FORGE & MACHINE CO. • MODERN DROP FORGE CO. • MOLINE FORGE, INC. • MONDIE FORGE CO., INC. • MOORE DROP FORGING CO. • OCTIGAN FORGE DIVISION, H & B AMERICAN MACHINE COMPANY, INC. • PENNSYLVANIA FORGE CO. • PETTIBONE-MULLIKEN CORP. • PHOENIX MANUFACTURING CO. • PITTSBURGH FORGINGS CO. • POOR & COMPANY, CANTON FORGE & AXLE WORKS • H. K. PORTER COMPANY, INC., CLEVELAND DIVISION • PORTER FORGE & FURNACE, INC. • PORTLAND FORGE & FOUNDRY CO. • THE PROTO TOOL COMPANY • THE QUEEN CITY FORGING CO. • RHODE ISLAND TOOL CO. • ROCKFORD DROP FORGE CO. • STANDARD FORGINGS CORPORATION • THE STEEL IMPROVEMENT & FORGE CO. • STORMS DROP FORGING CO. • TAYLOR FORGE & PIPE WORKS • TRANSUE & WILLIAMS STEEL FORGING CORP. • TRINITY FORGE, INC. • UNION FORGING CO. • UNIT DROP FORGE, DIVISION OF FULLER MFG. CO. • WALKER FORGE, INC. • WALLACE FORGING, DIE & TOOL CO. • WARREN TOOL CORP. • WEBB FORGING COMPANY • WILCOX-CRITTENDEN DIVISION, NORTH & JUDD MFG. CO. • WILCOX FORGING CORP. • WILDE TOOL CO., INC. • J. H. WILLIAMS & COMPANY • WYMAN-GORDON COMPANY.

Circle 478 on Page 19

ALL NEW . . . AND
Shock Resistant!
hoover
ANN ARBOR MICHIGAN

Hoover pillow blocks with ductile cast housings

Hoover introduces a new, economical pillow block ball bearing unit with cast housing of ductile material that absorbs shock and vibration, assuring long bearing life. It is designed to carry light loads at normal speeds.

The unit contains a pre-lubricated bearing featuring ultra-smooth *Hoover Honed* raceways and a perfectly matched set of *Micro-Velvet* balls, a guarantee of unexcelled quality. Known as the E D series, these new pillow block bearings are available in shaft sizes from ½" to 1$\frac{3}{16}$".

Hoover also offers a cast iron pillow block bearing for light to medium load conditions, plus a wide range of flange and machine units.

NEW BULLETIN 106 DESCRIBES COMPLETE LINE OF NEW HOOVER PILLOW BLOCK BALL BEARINGS!

Please return coupon for your copy

MD-4

Hoover Ball and Bearing Company
5400 South State Road, Ann Arbor, Michigan

Please send new Bulletin 106, which describes Hoover pillow block ball bearings.

Name____________________

Title____________________

Company____________________

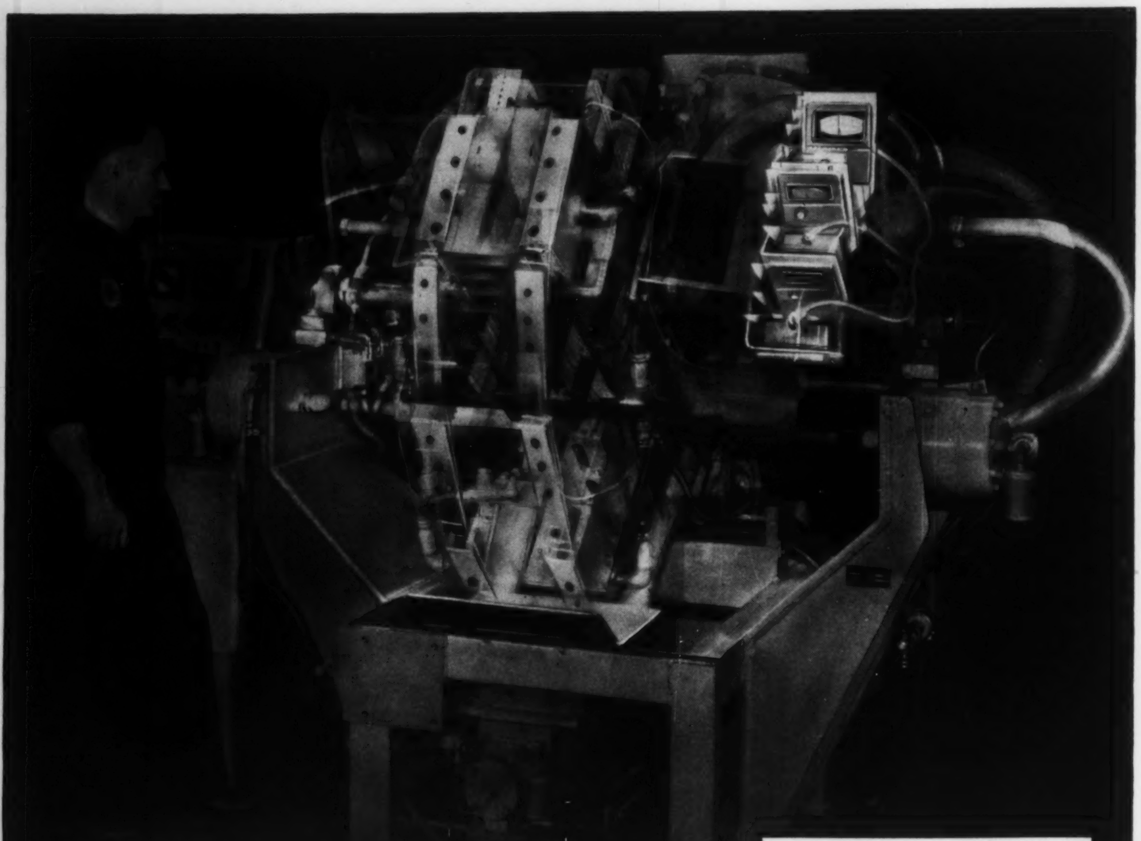
Address____________________

City__________ Zone____ State____

hoover

BALL AND BEARING COMPANY
5400 South State Road, Ann Arbor, Michigan
Sales Offices and Warehouses: 2020 South Figueroa, Los Angeles 7, California
290 Lodi Street, Hackensack, New Jersey

Hoover Honed and *Micro-Velvet* are Hoover trademarks.



A Partlow Model MFS indicating controller is shown in action in this "multiple exposure" shot of a Holo-Core Automatic Molding Machine manufactured by Spo, Inc., Cleveland, Ohio.

The Temperature Control Built to SHRUG OFF SHOCK *2438 Times a Day*

Every working day, the Partlow Temperature Control in this photo takes between 2400 and 2500 solid "roundhouse punches" from the shell-molding machine to which it is attached.

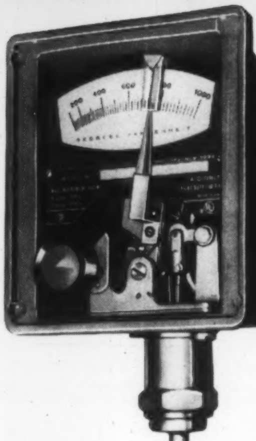
But despite jarring shock and vibration, and a constant barrage of foundry dust, the Partlow goes right on delivering precision control—without letup or breakdown.

Actually, only a control as simple and rock-solid as the Partlow could withstand this kind of punishment! Because only the Partlow contains no hairsprings, or delicate gadgets.

All Partlow thermal elements of the same range are interchangeable *on the job*, too. There's no time lost waiting for your control to come back from the factory. And you get this extra margin of dependability *without loss of accuracy*. Partlow controls are precise to within 1% of scale in any one of 10 ranges from -30° to 1100° F.

If you use or manufacture equipment within this temperature range, there's a Partlow to fit your application exactly . . . and save you money, too. Available in Pneumatic, Electric or Self-Contained Gas types, in recording, indicating or non-indicating models! To field test any Partlow control . . . or to obtain full details write, The Partlow Corporation, New Hartford, N. Y. Dept. D-459.

Export: Ad. Auriema, Inc., 85 Broad St. New York 4, N. Y.



A complete absence of gadgets and superfluous parts, as seen in this open view of the new MFS indicating control, explains the Partlow's unique ability to function accurately even under the most severe operating conditions.

You can pay more but you can't buy better than

PARTLOW

TEMPERATURE CONTROLS

A Y Globe that challenges comparison shows it pays to

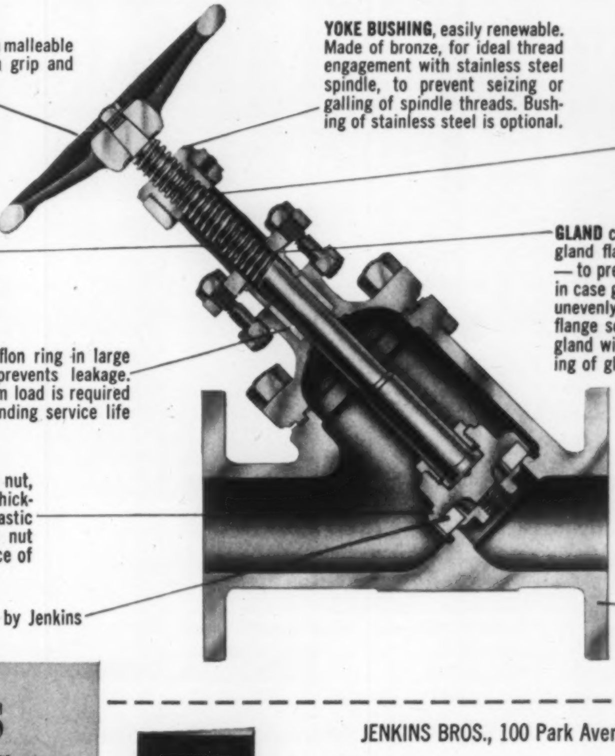
Specify JENKINS for STAINLESS STEEL Valves, too

Want the "best buy" in Stainless Steel Y Globe Valves? Compare this Jenkins Fig. 1335 with any on the market. You'll conclude that it's hard to beat Jenkins at making valves, no matter what the material.

You'll find genuine superiority of design and construction in the features shown here. But no picture can show the quality of the castings . . . the precision machining . . . the rigid inspection and testing that have gone into this valve. All of these are as important as design and metal alloys in assuring long, dependable, economical valve service. And, all of them are up to the peak standards for which Jenkins has been known for almost a century.

SEND FOR NEW CATALOG of Jenkins Stainless Steel Valves, in patterns and alloys that satisfy the requirements of practically all corrosive services.

These Jenkins Valves meet valve industry specifications and the high standards established by leading users of stainless steel valves.



WHEEL of high strength malleable iron designed for firm grip and easy operation.

YOKE BUSHING, easily renewable. Made of bronze, for ideal thread engagement with stainless steel spindle, to prevent seizing or galling of spindle threads. Bushing of stainless steel is optional.

YOKE BONNET, a single unit, has liberal space between yoke arms for easy access to packing box. Tongue and groove joint with body makes a pressure-tight seal with less tightening on the bolts, and eliminates possibility of blowing out the Teflon gasket.

SPINDLE of large diameter and dense structure has high resistance to wear and torsion strains. Easy, tight closing is assured by long, precision machined thread bearing surfaces. A beveled shoulder provides backseating against inside of bonnet, permitting repacking under pressure.

GLAND consists of two pieces — gland flange and gland follower — to prevent binding of follower in case gland bolts are tightened unevenly. Crowned surface of flange secures tightness against gland without excessive tightening of gland nuts.

PACKING A Teflon ring in large packing box prevents leakage. Only a minimum load is required on gland, extending service life of packing.

DISC HOLDER, held by lock nut, has depth equal to disc thickness, preventing flow of plastic disc. Wide disc retaining nut covers all but seating surface of Teflon disc.

BODY Through-port design for full, free flow. Liberal seat height permits repeated refacing. Cast on body are directional arrow and bosses for drain connections. End flanges conform to M.S.S. specifications.

DISC is Teflon made by Jenkins

JENKINS
LOOK FOR THE JENKINS DIAMOND
JENKINS SINCE 1864
VALVES
Jenkins Bros

Sold Through Leading Distributors Everywhere

JENKINS BROS., 100 Park Avenue, New York 17, N. Y.

☐ Send the new stainless steel valve catalog

☐ Have a representative call on me

NAME & TITLE..........

COMPANY..........

ADDRESS..........

Circle 481 on Page 19

crimp-type

MODULAR ELECTRICAL CONNECTORS

IN 3 NEW BASIC TYPES

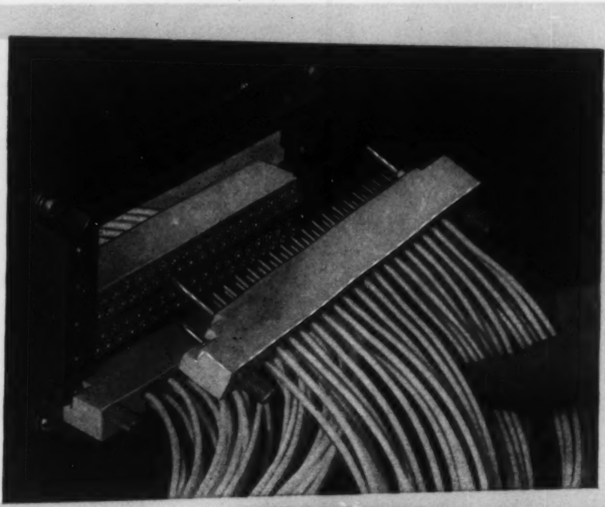
Modular units by Burndy provide versatile, rapid and reliable answers to the problem of connecting a multiplicity of wires in relatively limited spaces. Crimped contacts—installed with any of several hand, pneumatic, semi-automatic or automatic tools—can be removed, re-inserted or replaced, providing the most complete flexibility in the connector field. Computers, ground-based radar, missile ground controls, and instrumentation are typical applications for Burndy modular connectors.

feed-thru,
multiple
insert

HYFEN® connector

with crimp-type,
snap-locked
contacts

Makes possible the design of lighter and more compact equipment. Each insert holds 35 contacts. Frames available for 5 or 8 inserts.

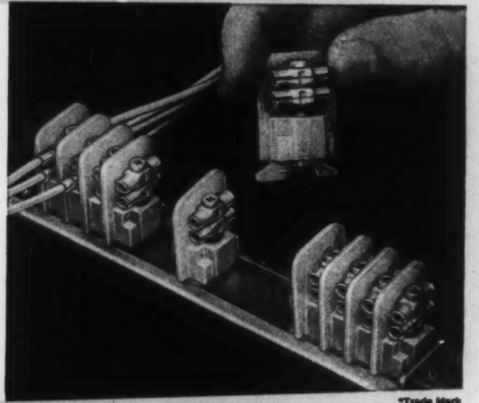


quick-disconnect
or permanently
connected

MODULOK* terminal block

with snap-in,
spring-loaded
contacts

True versatility in a terminal block. 30 modules (2 or 4 tier) per foot. Twist of a screwdriver transforms quick-disconnect contacts to permanent connections.

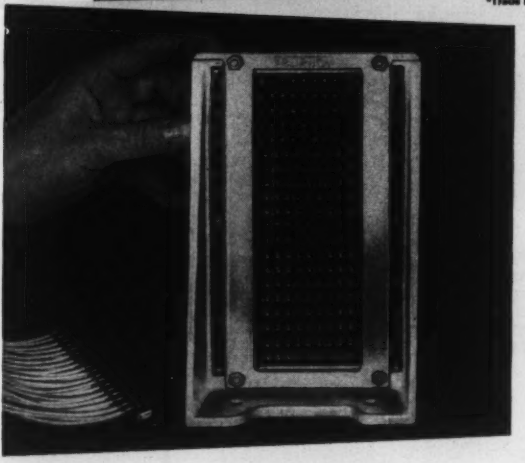


*Trade Mark

crimp-type,
solid-shank

STAPIN® taper pin contacts

Another Burndy contribution to the modular concept of assembling standard units to provide custom-fitted end products.



For complete information, write: OMATON DIVISION

BURNDY

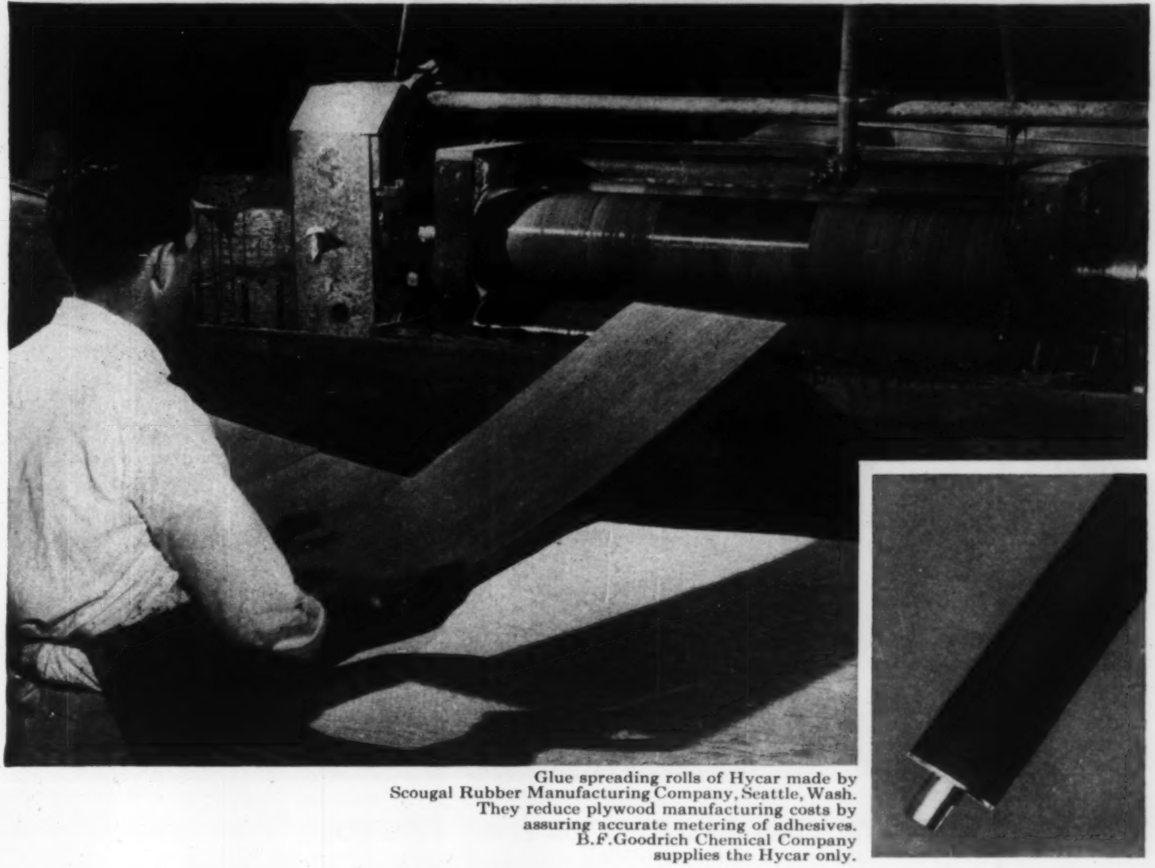
58-24

Norwalk, Connect. **In Europe: Antwerp, Belgium** **Toronto, Canada**

Circle 482 on Page 19

Another new development using

B.F.Goodrich Chemical *raw materials*



Glue spreading rolls of Hycar made by Scougal Rubber Manufacturing Company, Seattle, Wash. They reduce plywood manufacturing costs by assuring accurate metering of adhesives. B.F.Goodrich Chemical Company supplies the Hycar only.

Pleased plywood makers tell...

How spreader rolls of Hycar solve adhesive laminating problems

Until manufacturers of spreader rolls discovered the advantages of Hycar nitrile rubber, spreading adhesives on plywood veneers was quite a problem. The tiny grooves in rolls that are responsible for accurate metering and spreading had to be ground accurately —Hycar lets makers grind to tolerances unusually fine for rubber.

And grooves have to maintain their toughness and posture. Long-wearing Hycar extends life of rolls. Unlike other materials tested, it does not absorb the oils and solvents used in modern glues. Which means the rolls of Hycar can be counted on to meter glue evenly. They are more easily cleaned after use, too.

Regardless of these tough operating conditions, Hycar retains its springy resiliency and vigorous elasticity. It's another example of an improved application made possible through use of Hycar nitrile rubber. You can get more information by writing Dept. CM-2, B. F. Goodrich Chemical Company, 3135 Euclid Avenue, Cleveland 15, Ohio. Cable address: Goodchemco. In Canada: Kitchener, Ontario.

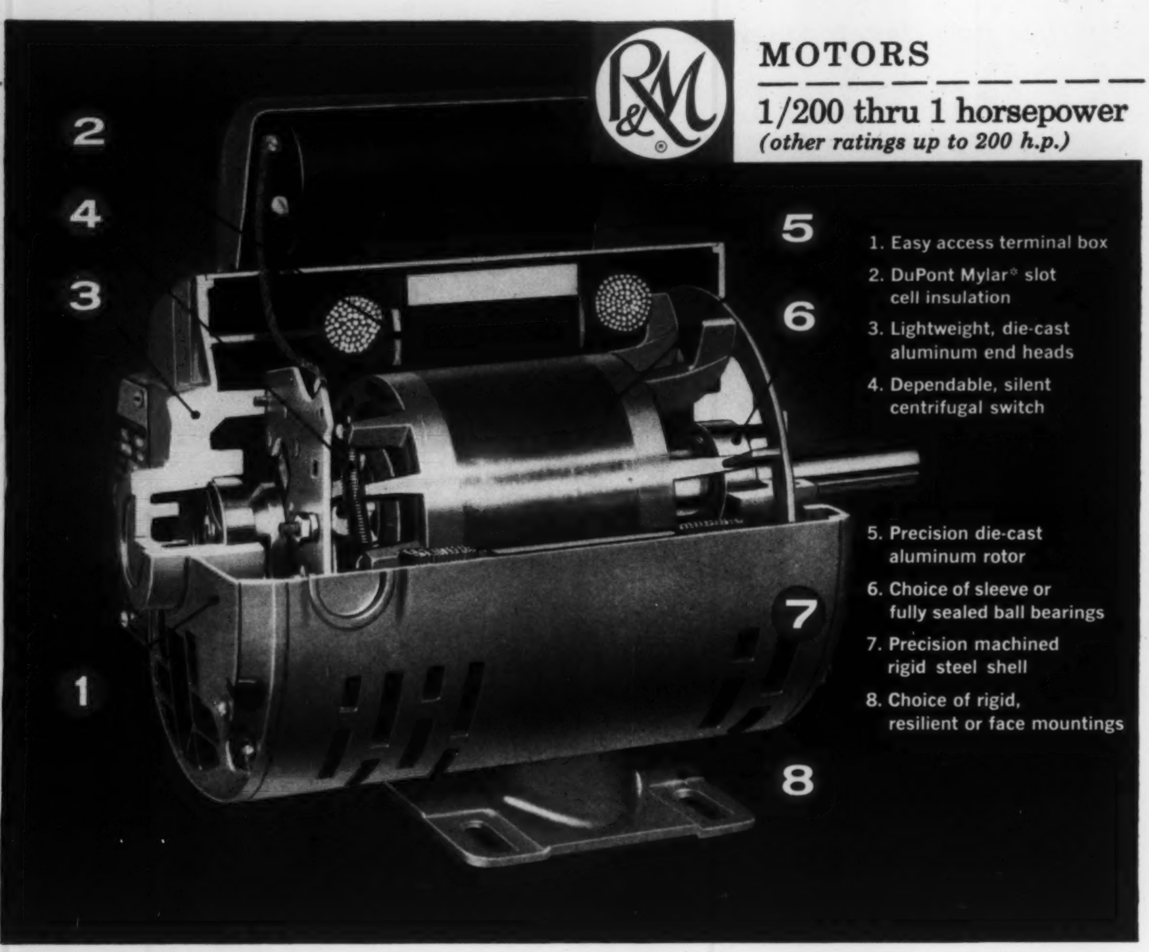
Hycar
Reg. U.S. Pat. Off.
Rubber and Latex

B.F.Goodrich Chemical Company
a division of The B.F.Goodrich Company

B.F.Goodrich

GEON polyvinyl materials • HYCAR rubber and latex
GOOD-RITE chemicals and plasticizers • HARMON colors

Circle 483 on Page 19

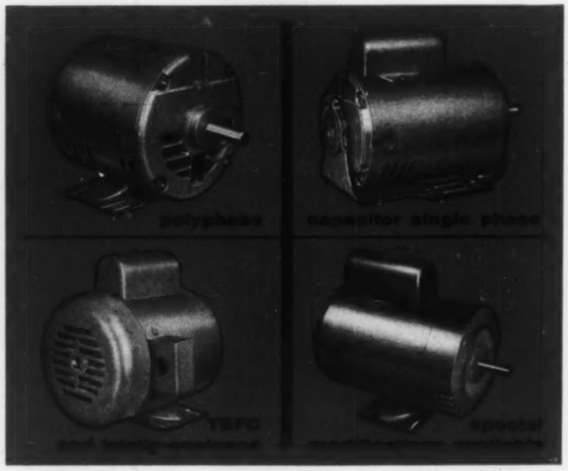


MOTORS

1/200 thru 1 horsepower
(other ratings up to 200 h.p.)

1. Easy access terminal box
2. DuPont Mylar* slot cell insulation
3. Lightweight, die-cast aluminum end heads
4. Dependable, silent centrifugal switch
5. Precision die-cast aluminum rotor
6. Choice of sleeve or fully sealed ball bearings
7. Precision machined rigid steel shell
8. Choice of rigid, resilient or face mountings

R & M Fractional Horsepower Motors are packed with *Competitive Advantages* for your product!



Robbins & Myers "Model R" fractional HP motors, available in NEMA frames 56 and 48, are engineered and manufactured to give your product every possible competitive advantage so far as power is concerned. Each design detail results in superior performance and long trouble-free life, even under the severest operating conditions. They are smaller due to a more efficient ventilating system and lighter because of new applications of aluminum, steel and copper.

You have wider design versatility too, because they are available off-the-shelf in a broad choice of bearings, mountings, ratings, speeds and electrical characteristics.

These up-to-date design features, coupled with careful quality control at each manufacturing step, give you a modern motor you can rely on for all your powering needs. Also, if your needs indicate a custom designed motor Robbins & Myers welcomes the opportunity to discuss your quantity requirements.

Learn all about the many advantages R&M motors offer you by writing today for Bulletin 450 MD

**DuPont registered trademark*

ROBBINS & MYERS, INC.

motors, household fans, Propellair industrial fans, hoists, Moyno industrial pumps

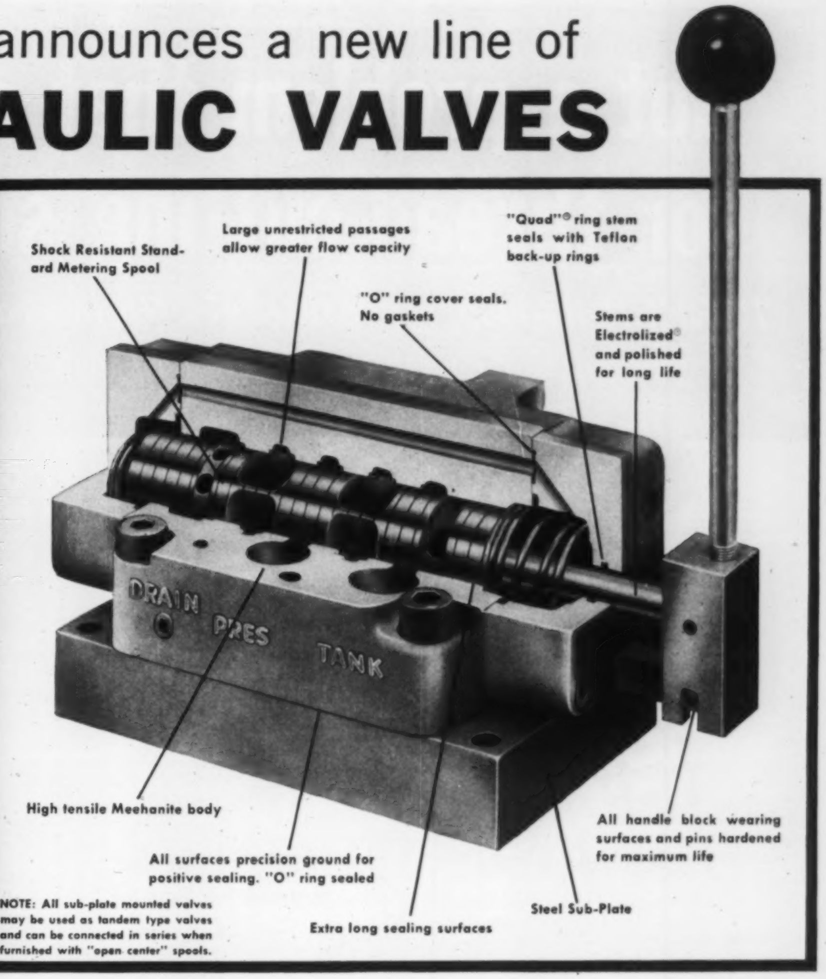
SPRINGFIELD, OHIO · BRANTFORD, ONTARIO

Circle 484 on Page 19

Rivett announces a new line of

HYDRAULIC VALVES

3000 PSI; sub-plate mounted; manually operated


Shock Resistant Standard Metering Spool
Large unrestricted passages allow greater flow capacity
"Quad"® ring stem seals with Teflon back-up rings
"O" ring cover seals. No gaskets
Stems are Electrolized® and polished for long life
DRAIN
PRES
TANK
High tensile Meehanite body
All surfaces precision ground for positive sealing. "O" ring sealed
Extra long sealing surfaces
Steel Sub-Plate
All handle block wearing surfaces and pins hardened for maximum life

NOTE: All sub-plate mounted valves may be used as tandem type valves and can be connected in series when furnished with "open center" spools.

Reliable performance through precision manufacturing

Rivett Series 6100 Hydraulic Valves are the latest in design, furnishing accurate, positive control of hydraulic power. Developed by engineers long experienced in fluid power, these valves offer economical, efficient operation as well as trouble-free maintenance and long-life. Featuring unrestricted passages to permit greater flow capacity, the 1" size in the Series 6100, for example, is rated at 28.2 gpm at 15 ft. per sec. Piston action is noted for smooth, positive opening and closing.

New catalog simplifies selection and ordering

RIVETT
Hydraulic Valves

Rivett's new easy-to-use Valve Catalog No. 210 puts complete information on performance, ratings, dimensions, mountings and ordering instructions at your finger tips. Write today for your copy of Catalog No. 210.

The better you know hydraulics . . . the better you like →

RIVETT

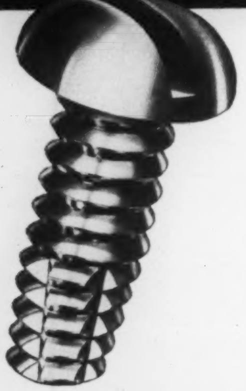
HYDRAULIC VALVES

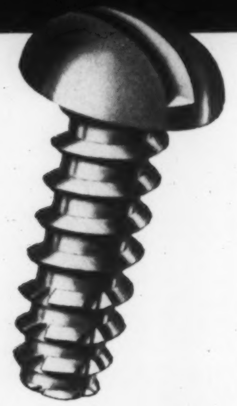
RIVETT, INCORPORATED, DEPT. MD-4
Brighton 35, Boston, Massachusetts
Member National Fluid Power Association

Circle 485 on Page 19

Got a problem that calls for thread-cutting screws?

PARKER-KALON offers three new, improved thread-cutting screws for every application in every material





1 New, Improved P-K Type F*

. . . hardened thread-cutting screws developed for use in friable, granular or brittle material. The pilot, with its five tapping flutes, cuts a machine screw thread as the screw is turned in. The Type F is ideal for making fastenings to ferrous and non-ferrous castings, bronze or brass forgings, heavy gage sheet metals, structural steels, plastics and resin-impregnated plywood.

2 "Pentap" . . . the new, Improved P-K Type B-F*

(formerly F-Z) combining the five thread-cutting flutes of the Type F screw with the coarse-pitch, widely-spaced threads of the P-K Type B. The thread-cutting "Pentap" Type B-F distributes cutting pressure evenly, lets chips drop to the bottom of the hole, and prevents cracking of material. It is designed for making fastenings to comparatively thin sections and bosses in friable and brittle plastics.

The five cutting flutes on the new, improved P-K Type "F" and "BF" reduce pressure development by 80 percent! The completely formed threads on these screws have sharper cutting edges, and 5 deep flutes that are of continuous depth. These features make for better clearance of the accumulated material and assure minimum stresses in driving, and avoid the possibility of stripping or galling.

3 P-K® Type L†

. . . is a completely new and improved thread-cutting screw developed by Parker-Kalon especially for use in Nylon. The Type L functions as a combination thread-cutting and thread-forming screw in that it cuts a small amount of the Nylon to allow the full diameter threads to form. Type L offers a particular advantage in Nylon assemblies which must be disassembled for service, because *the P-K Type L can be removed and replaced without stripping or galling.*

FOR SEMS . . . and Neoprene or Nylon washer STAPS® in thread-cutting and thread-forming tapping screws, or machine screws in any kind of pre-assembled fastener-washer combination, P-K can supply them, too!

KEEP AMERICAN INDUSTRY AT WORK . . . BUY P-K . . . MADE IN U.S.A.

*Patent Pending †U. S. Patent 2,350,346

FOR SAMPLES OF P-K THREAD-CUTTING SCREWS AND SEMS, CALL YOUR LOCAL P-K "BULK-STOCKING" DISTRIBUTOR

PARKER-KALON®
fasteners

PARKER-KALON DIVISION, General American Transportation Corporation, Clifton, New Jersey • Offices and Warehouses in Chicago and Los Angeles

CLARE Lowers Prices

on all Mercury-wetted contact relays

C.P. CLARE & CO.
CHICAGO

Type HG

HGP1004
C.P. CLARE & CO.

Type HGP

HGS1011
C.P. CLARE & CO.
CHICAGO

Type HGS

Type HG2

Type HG4

Reductions range from 7½% to 10%

When prices for just about everything are continuing to rise, and all thinking men are concerned over the danger of inflation, it is important news when a manufacturer makes a significant price reduction.

Increased production resulting from the wide acceptance of Clare Mercury-Wetted Contact Relays, together with improvements in skill and in manufacturing equipment and methods, make it possible for Clare to reduce prices for these superior relays in spite of rising labor and material costs.

A price reduction ranging from 7½% to 10% will be applied to all orders placed after March 31, 1959, for Clare Mercury-Wetted Contact Relays—Types HG, HGP and HGS. The reduction will also affect multi-element relays such as HG2, HG3, HG4, etc.

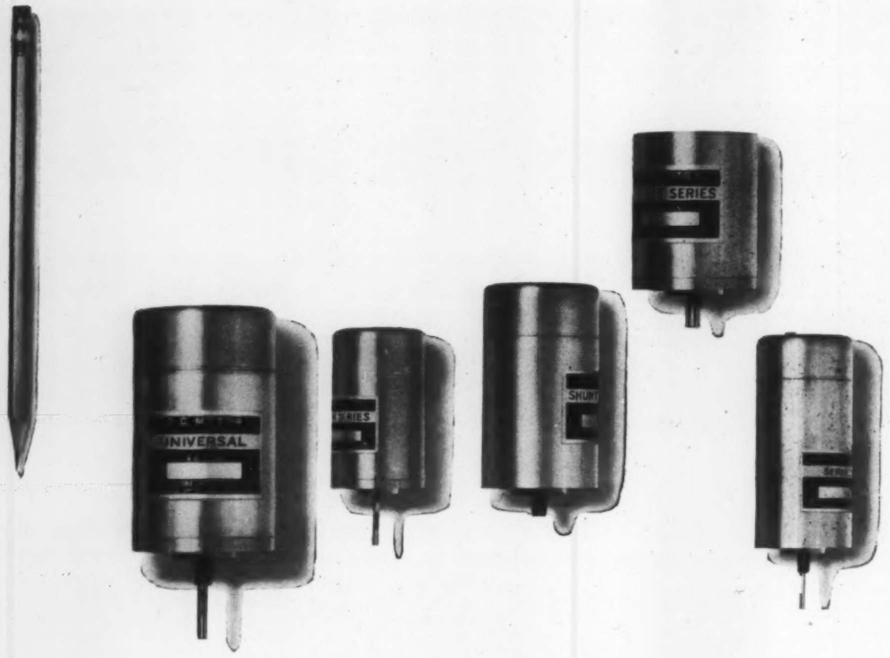
These lower prices for relays whose life is measured in *billions of maintenance-free operations* will be exciting news to all designers of continuous-duty, high-speed switching devices and systems.

Write or Wire: C. P. Clare & Co., 3101 Pratt Blvd., Chicago 45, Illinois. In Canada: C. P. Clare Canada Ltd., 2700 Jane Street, Toronto 15. Cable Address: CLARELAY.

CLARE RELAYS

FIRST in the industrial field

Circle 487 on Page 19



NEW WOUND FIELD MOTORS / VERSATILE

Precision miniature wound field d.c. motors in five basic frame sizes (to 2¼″ OD and to 1/10 hp) and in countless variations are now available from Globe Industries. You can design them into many military and other high quality products because they meet such an enormous variety of power and duty requirements. **Examples:**

Split-series units reverse rapidly and simply with a SPDT switch. Series units start with relatively high torque, low current drain. Shunt wound varieties offer means for low current control. Universal motors operate on a.c. or d.c. Globe-designed gear reducers, brakes and clutches can be built into the unit, and Globe can efficiently design and build the motor and accessories into a special motorized device.

If you'd like to look into miniature wound field motors of **any** description, or combine them with other components, ask the largest manufacturer of precision miniature motors first. Request technical Bulletin WF-1. GLOBE INDUSTRIES, INC., 1784 Stanley Avenue, Dayton 4, Ohio.

GLOBE INDUSTRIES, INC. **GLOBE**

Circle 488 on Page 19

FORMICA Laminated Plastic field fabricating

now... Streamliner service on fabricated parts

FIF

Fabricator of Industrial Formica laminated plastics

Formica® Field Fabricating better 3 ways:

1 Faster delivery on a totebox-ful or a truckload

2 Highest quality assured by fabricating specialists and modern equipment

3 24-hr. delivery on standard Formica sheets and rods

FI-2076

Need a part fabricated quickly for prototype development? Need a truckload of parts to keep your production lines running? Call your local Fabricator of Industrial Formica laminated plastics. One or one million, he'll *fabricate and deliver* your Formica laminated plastic parts on a Streamliner schedule—within 24 hours in some cases.

He's located near you, offers more frequent contact. In many cases he stocks standard Formica sheets and rods for Streamliner delivery in a matter of hours.

The new Formica field fabricating service is without equal. It can save you time and money in more efficient parts procurement. Write us for complete information and the name of the fabricator nearest you. Formica Corporation, subsidiary of American Cyanamid, 4514 Spring Grove Ave., Cincinnati 32, Ohio.

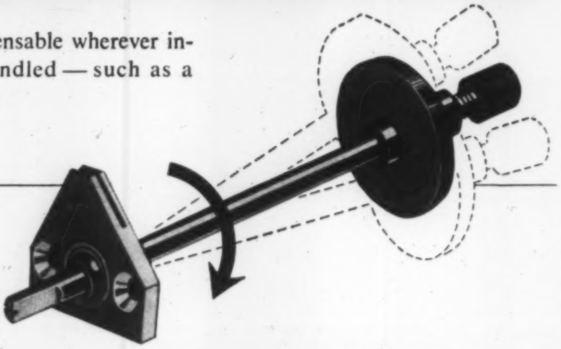
FORMICA Laminated Plastic *a product of* CYANAMID

All the Best Features of a 2-piece Spherical Bearing
PLUS_ Self-Lubrication . . . . .

HEIM *Unibal*®

SINTERED POWDERED METAL SPHERICAL BEARINGS

The Heim Spherical Bearing is indispensable wherever intentional misalignment must be handled — such as a rotating shaft requiring lateral motion.



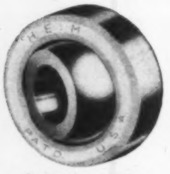
HEIM-LH-16
PAT'D. U.S.A.

For applications where the bearing is easily accessible for re-lubrication, and where static radial loads to 650,000 lbs. are to be carried, the LH and LRH series Unibal Spherical Bearings are made with outer members of aircraft quality alloy steel hardened, and balls of SAE 52100 steel hardened.

HEIM
PAT'D. U.S.A.

Spherical Bearing made by powder metallurgy method

Cutaway shows large surface-supporting area



Designed to correct maximum misalignment

The same type bearing is now available with balls made of high-density, through-hardened powdered iron alloy, and outer members of sintered iron or sintered bronze with controlled porosity.

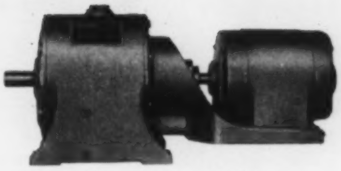
Heim Unibal Powder Metallurgy Spherical Bearings are self-lubricating (hold up to 20% of their own volume in oil). Longer bearing life is assured.

The Heim Engineering Department will advise you on sizes, capacities, and speeds. Please write direct, or contact any of the leading Bearing Distributors.

THE HEIM COMPANY
FAIRFIELD, CONN.

Circle 490 on Page 19

NOW AVAILABLE!

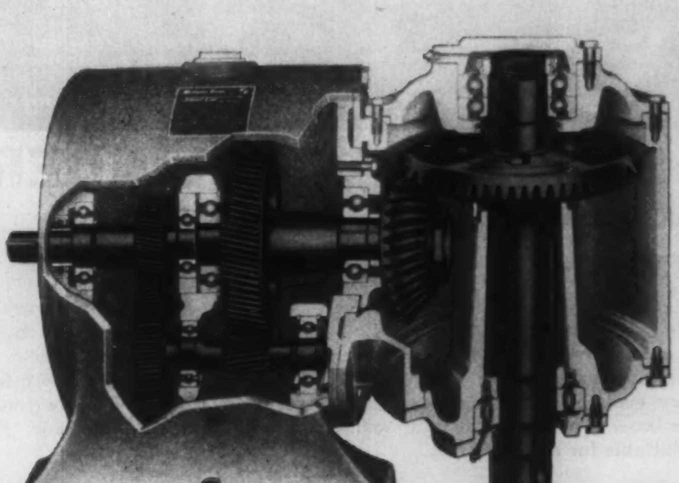


all-motor gearmotor

integral gearmotor

Built-in customer benefits, engineered to customer needs for more than 25 years, make the Western Gear StraitLine Speed Reducers line the finest in the field. The reducer and right angle head pictured below are available in ranges from 1 HP to 75 HP, with or without motor. Let our engineers consider your needs.

WESTERN GEAR
STRAITLINE *speed reducers with universal-mounted right angle head!*



UNIVERSAL MOUNTING. The right angle attachment may be furnished in horizontal, vertical or intermediate positions with single or double extended shafts.

SPIRAL BEVEL GEARING. Precision cut from alloy steel forgings and case hardened for maximum strength and durability. Each set of gears is matched and lapped after hardening to insure good contact and quiet operation.

DRY WELL CONSTRUCTION. Time tested dry well construction prevents oil leakage down the output shaft for vertical applications.

OVERHUNG LOAD. Conservatively selected bearings, husky output shaft, and wide bearing span provide ample overhung load capacity for chain, pinion and belt service.

POSITIVE LUBRICATION. A simple splash lubrication system, integral with the main housing, thoroughly lubricates gears and bearings. Case design allows oil to be circulated freely at all times.

LESS MAINTENANCE. Only two alemite fittings are required to lubricate bearings when output shaft is in the vertical position. Large grease reservoirs are provided to insure positive lubrication.

WESTERN GEAR CORPORATION
Industrial Products Division
P.O. Box 126 • Belmont, California
Send me Bulletin 5816F

*name*____________________
*title*____________________
*company*____________________
*address*____________________
*city*__________*state*__________

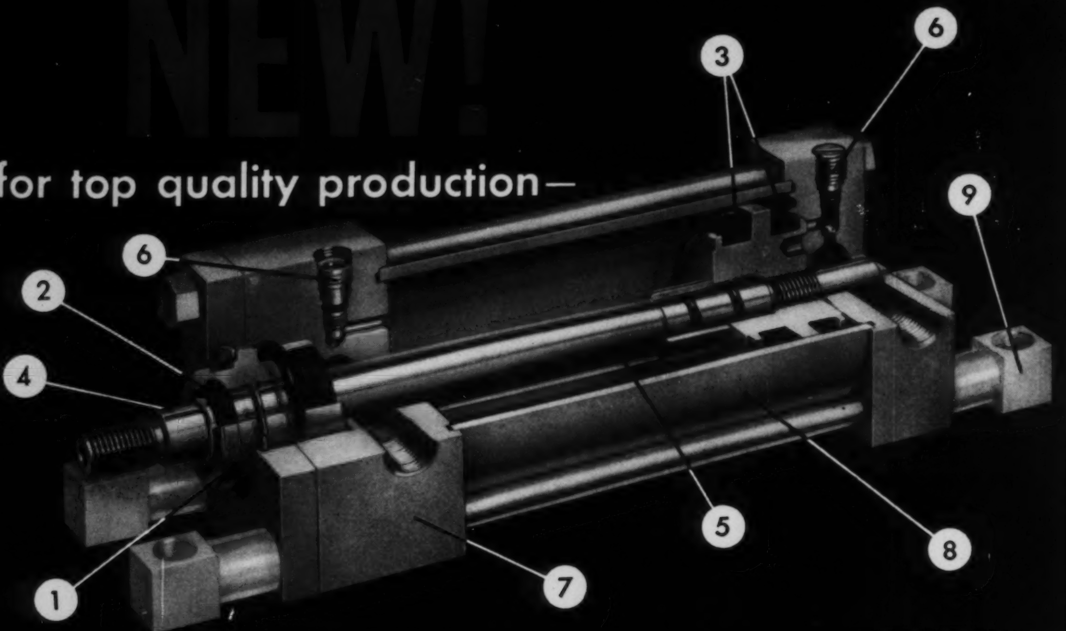
5902

WG INDUSTRIAL PRODUCTS DIVISION

Circle 491 on Page 19

NEW!

for top quality production—



1. Bronze Bearing, with self-adjusting "U" Cup Piston Rod Seal for longer wear.
2. Rod Wiper protects Piston Rod Seal and keeps Cylinder clean.
3. "U" Cup Seals expand with pressure to provide positive seal with minimum friction.
4. Wrench Flats make for easy installation.
5. Ground, hard chrome-plated Piston Rods have minimum yield strength of 125,000 psi.
6. Self-locking cushion adjusting screw and ball check are below surface for protection . . . easily accessible.
7. For extra strength, Cylinder Ends and Mounting Plates are machined from bar stock and steel forgings.
8. Cylinder is precision-finished brass for extra heavy duty.
9. Variety of mountings can be interchanged—easily match any installation requirement.
10. Interchangeable with all JIC Cylinders.

SCHRADER SQUARE-END CYLINDERS

meet and exceed JIC specs . . . 250 psi air . . . 750 psi hydraulic!

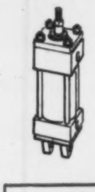
Here's compact, versatile straight-line power. Just look at the features!

Use Schrader's new square-end double-acting cylinders for holding, positioning, moving work—for push, pull or lifting—for automating manual operations. In five sizes up to 4-inch bore, and with five interchangeable mountings, these "square-ends" are economical and versatile. Bolt, leg, flush, side flush or base . . . each JIC Cylinder will mount all five ways. Suitable for air pressures to 250 psi, or hydraulically to 750 psi—available cushioned or non-cushioned.

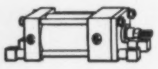
You get safe, controlled, low-cost power with Schrader "square-ends"—another addition to the line of famous Schrader quality Air Control Products.

Complete stocks available locally—expert help to improve your air control hookups. Write for your complete specifications and data on these new "square-ends."

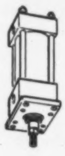
Bolt Mounting



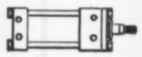
Leg Mounting



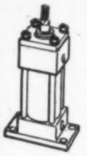
Flush Mounting



Side-Flush Mounting



Base Mounting

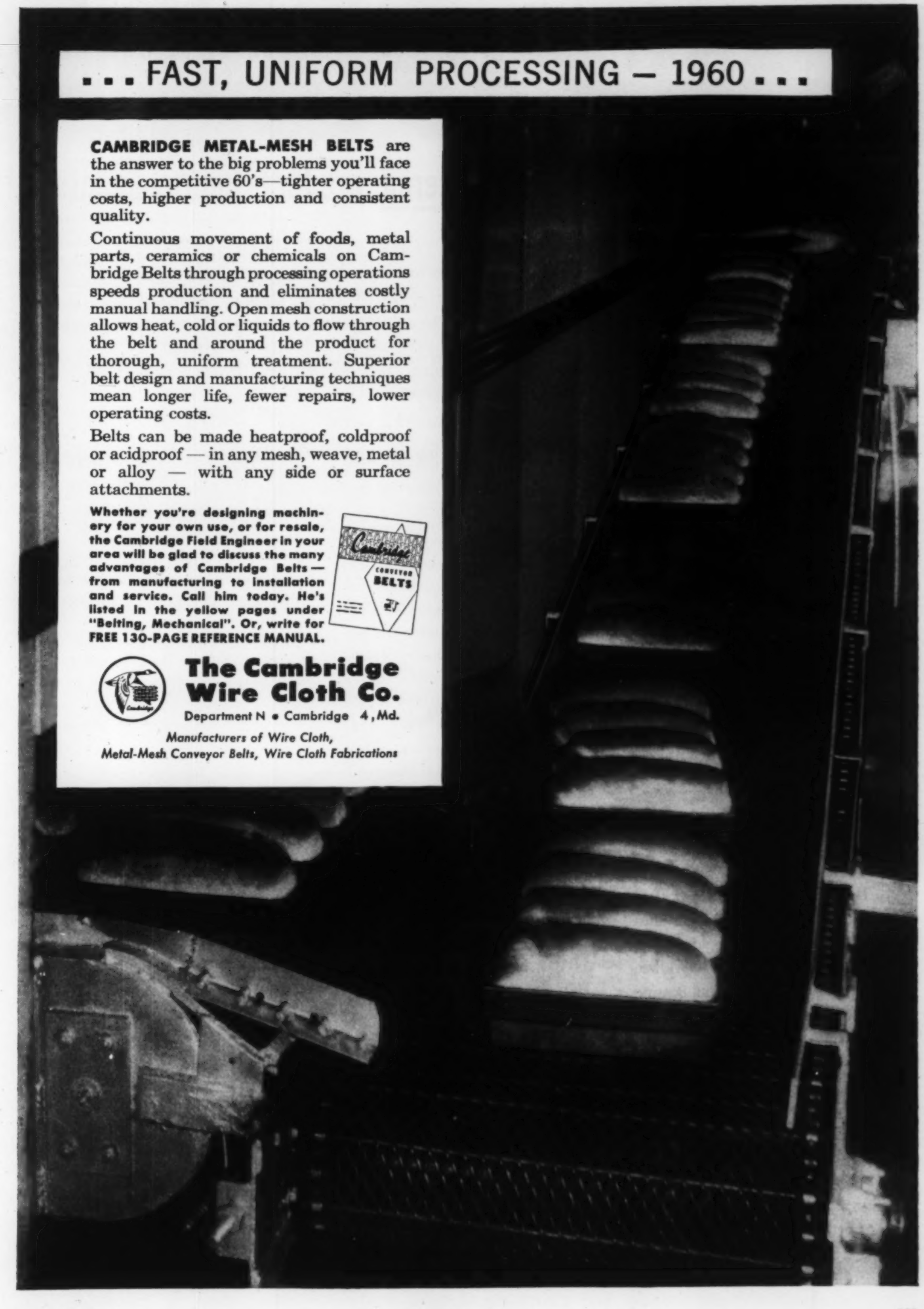


Schrader
a division of **SCOVILL**

A. SCHRADER'S SON
Division of Scovill Manufacturing Co.
476 Vanderbilt Avenue, Brooklyn 38, N. Y.

QUALITY AIR CONTROL PRODUCTS

Circle 492 on Page 19



. . . FAST, UNIFORM PROCESSING — 1960 . . .

CAMBRIDGE METAL-MESH BELTS are the answer to the big problems you'll face in the competitive 60's—tighter operating costs, higher production and consistent quality.

Continuous movement of foods, metal parts, ceramics or chemicals on Cambridge Belts through processing operations speeds production and eliminates costly manual handling. Open mesh construction allows heat, cold or liquids to flow through the belt and around the product for thorough, uniform treatment. Superior belt design and manufacturing techniques mean longer life, fewer repairs, lower operating costs.

Belts can be made heatproof, coldproof or acidproof — in any mesh, weave, metal or alloy — with any side or surface attachments.

Whether you're designing machinery for your own use, or for resale, the Cambridge Field Engineer in your area will be glad to discuss the many advantages of Cambridge Belts — from manufacturing to installation and service. Call him today. He's listed in the yellow pages under "Belting, Mechanical". Or, write for FREE 130-PAGE REFERENCE MANUAL.

The Cambridge Wire Cloth Co.
Department N • Cambridge 4, Md.

Manufacturers of Wire Cloth,
Metal-Mesh Conveyor Belts, Wire Cloth Fabrications

THE DODGE STEEL ladle
DS
BUSINESS MAGAZINE EDITION

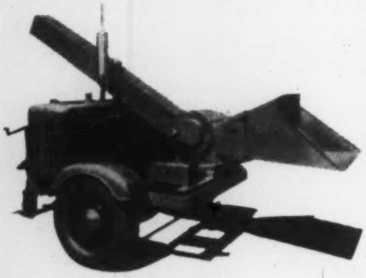
PUBLISHED BY **DODGE STEEL COMPANY**
6501 Tacony Street, Philadelphia 35, Pa.

Notes on Dodge foundry engineered product improvements

More and more designers and purchasers of steel castings are taking advantage of Dodge's unique 3-way engineering service to obtain better, more efficient parts. Complete facilities are available at Dodge to assist in the proper design and specification of a proposed new casting . . . to review present castings in order to determine how they may be redesigned to save metal and increase strength . . . and to help in converting other metals and forms to steel castings. Here are typical examples of the effectiveness of this service:

INGENIOUS TREE CHIPPER

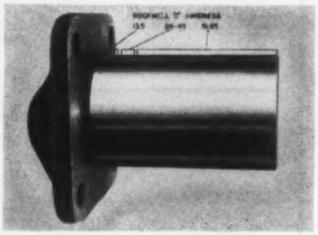
Helping to solve the brush disposal problem is this ingenious, portable Tree Chipper, that can be taken directly to the operation to "make little ones out of big ones".



A major part of the Chipper is a Dodge cast and machined steel roller, 9 inches long, 11½ inches in diameter and weighing 275 pounds. The cast steel roller, featuring three horizontal cutting blades, is so geared that it travels at a speed of 2,200 rpm. Brush and limbs up to 6″ diameter are fed into the machine and cut up into small chips. The use of a quality steel casting in this application assures uniform, predictable results, as well as long service life.

FAREWELL TO BREAKAGE

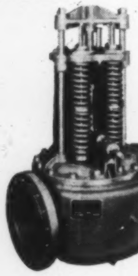
A well-known truck trailer manufacturer experienced extensive breakage of a trunnion pin in its trailer rear wheel tandem assemblies. The pin, used to support an equalizing beam, was not strong enough to take the punishing movement of heavy loads. New specifications called for a pin with a bearing surface ductile enough, yet with sufficient strength to do the job. Cost was to be kept low. Dodge designed, built, and machined the casting shown here.



The pin uses a special grade of Dodge steel which responds to differential grades of hardness along its surface, depending on the required stress demand. Result? Breakage problem eliminated with a steel casting produced at low cost.

STEAM LINE INSURANCE

In power plants and other systems utilizing high-pressure, high-temperature steam, the safety of workers as well as equipment is important. One safe and efficient pressure device—used in thousands of installations—is this relief valve made by a leading manufacturer.



Proper design coupled with the use of quality steel castings are good reasons why these valves have provided safe, efficient operation for so many years.

The best proof of the savings available to *your* company through the use of Dodge 3-way engineering service is the experiences of these manufacturers and others who have had problems similar to yours. This timely and valuable service is ready to go to work for you. May we study and solve your problem?

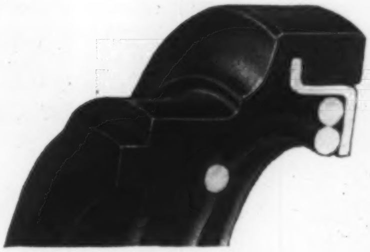
GITS ECONOMY SEALS

FOR HIGH-VOLUME COMMERCIAL USE

Economy is usually a primary consideration in high-volume commercial sealing applications. The Gits Commercial Seal Division specializes in design and manufacture of these and other seals for just such applications—with this economy requirement in mind.

MARK VI

For all types of water pumps. Useful in high-volume appliance and domestic water pump sealing applications. Rugged, durable, efficient. Specified where performance must be combined with economy.



STYLE SGU

A factory-assembled unit-type seal for household appliance manufacturers and other small-budget users — Disposal Machines, Washing Machines, Refrigerators.

Plus

these and other seals for standard

INDUSTRIAL APPLICATIONS

UNIT SEAL

A complete packaged sealing unit containing both rotating and stationary seal faces enclosed in metal housing. Used on Speed Reducers, Gear Motors and many other types of Power Transmission Equipment and Machine Tools.

STYLE DPC

An extra-rugged carbon- or bronze-faced seal, for more compact installation in heavy machine tools and other industrial machinery.

Write for detailed data

GITS BROS. MFG. CO.

COMMERCIAL AND INDUSTRIAL SEAL DIVISION

1868A South Kilbourn Avenue • Chicago 23, Illinois

Specialists in Lubricating Devices and Shaft Seals for Almost Half-A-Century

Circle 495 on Page 19

A plant built on the philosophy of "don't accept anything at face value"...

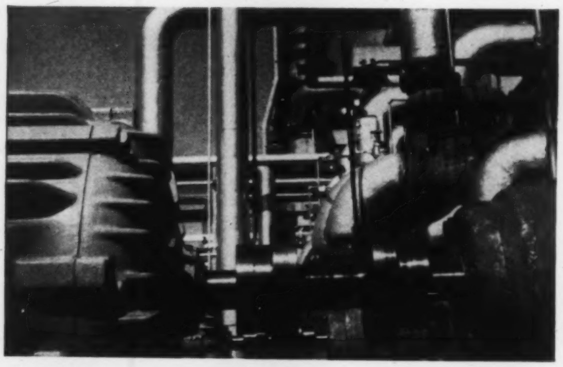
Tidewater's "Refinery of the Future" Uses 471 Fast's Couplings to Reduce Maintenance

IN PLANNING Tidewater's Delaware Refinery, all equipment purchases were examined from every angle . . . capital investment, manpower, maintenance and reliability. Fast's Self-Aligning Couplings were used throughout because they met Tidewater's exacting demands.

Tidewater's equipment design policies were established by survey teams that visited refineries all over the country. They carefully appraised each plant and asked operators what improvements they would make and what features they would retain if they were to redesign their drives.

In 471 applications at this refinery, Fast's Couplings guarantee mechanical flexibility that eliminates costly shutdowns and expensive shaft replacements. Fast's have the reputation of frequently outlasting the equipment they connect. This means savings in maintenance and down-time . . . in addition to protecting costly equipment against errors of alignment.

Nearly 40 years of coupling experience qualifies Koppers to solve *your* coupling problem. Write today for full details to: KOPPERS COMPANY, INC., Fast's Coupling Dept., 5604 Scott Street, Baltimore 3, Md.



Fast's Couplings give dependable, trouble-free service throughout Tidewater's entire production facilities.

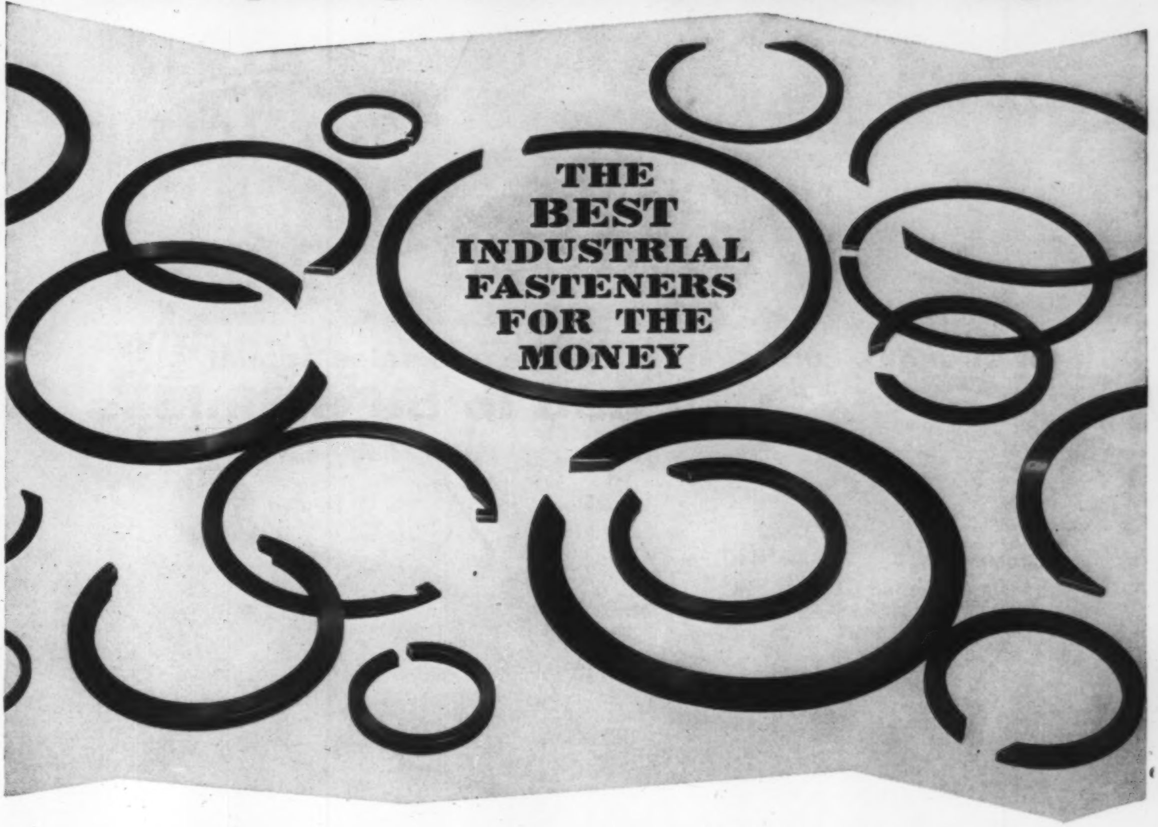
This Fast's Coupling drives a pump delivering heavy naptha to the Solutizing plant.

Engineered **Products**
Sold with ***Service***

KOPPERS

THE ORIGINAL
FAST'S Couplings

Holding parts in place is a snap with quality EATON-RELIANCE rings



For faster, more secure assembly of your products—with savings that will help you hold the line against rising costs—use quality snap, bearing, lock and retainer rings by Eaton-Reliance. You'll cut the cost of fabricating the parts of your product, too, because these versatile rings of a million uses reduce machining costs and simplify the design of individual parts. You can use Eaton-Reliance Rings as heat-treated shoulders on shafts and in counterbores to support bearings and other parts—with substantial savings in machining time, dead metal and final assembly.

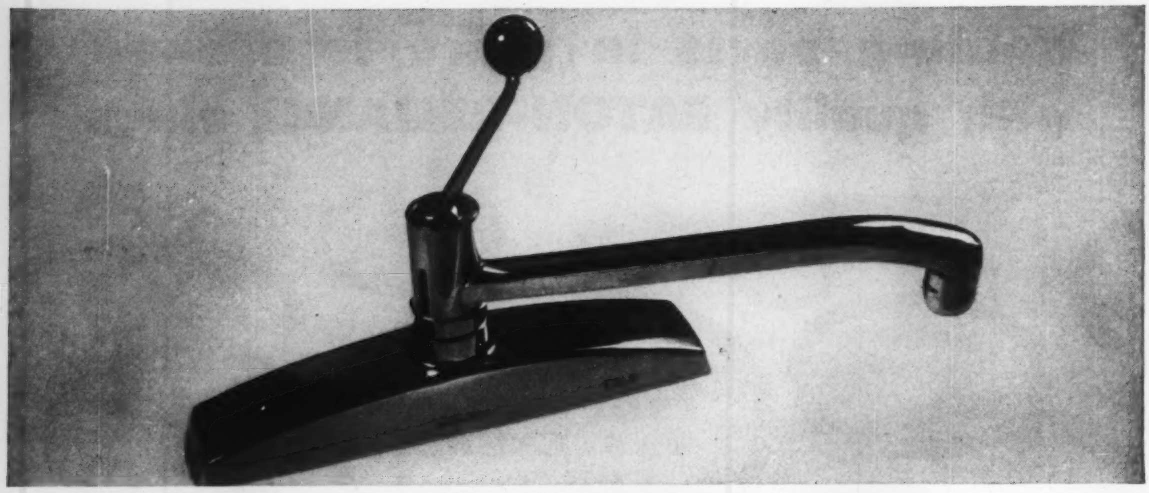
Eaton-Reliance Rings, manufactured on precision machines, are made of spring-quality steel, cold drawn in our own plant, and heat treated for the right measure of tension. End cuts and cross-sections are made to your exact requirements. From start to finish, we control every detail to assure you the highest quality rings which can literally hold your products together.

Without obligation to you an Eaton-Reliance fastener engineer will gladly study your product to show you how these versatile rings can cut its cost. Write for the name of the nearest representative, or send for Engineering Bulletin No. 55.

EATON — RELIANCE DIVISION —
MANUFACTURING COMPANY
506 CHARLES AVENUE • MASSILLON, OHIO

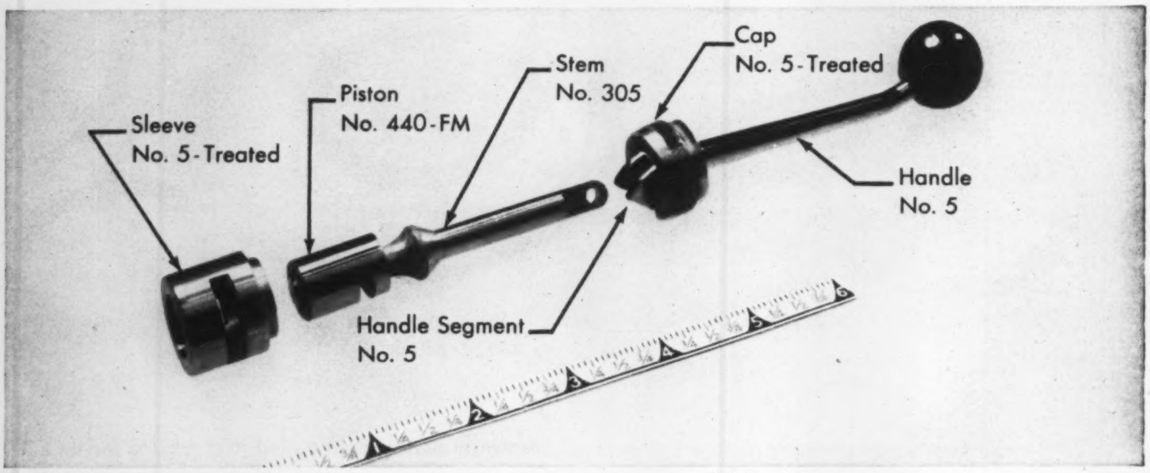
SALES OFFICES: New York • Cleveland • Detroit • Chicago • St. Louis • San Francisco • Los Angeles

PRODUCTS: Engine Valves • Tappets • Hydraulic Valve Lifters • Valve Seat Inserts • Jet Engine Parts • Hydraulic Pumps Motor Truck Axles • Permanent Mold Gray Iron Castings • Forgings • Heater-Defroster Units • Automotive Air Conditioners Fastening Devices • Cold Drawn Steel • Stampings • Gears • Leaf and Coil Springs • Dynamatic Drives, Brakes, Dynamometers



for strength, corrosion resistance and sales appeal

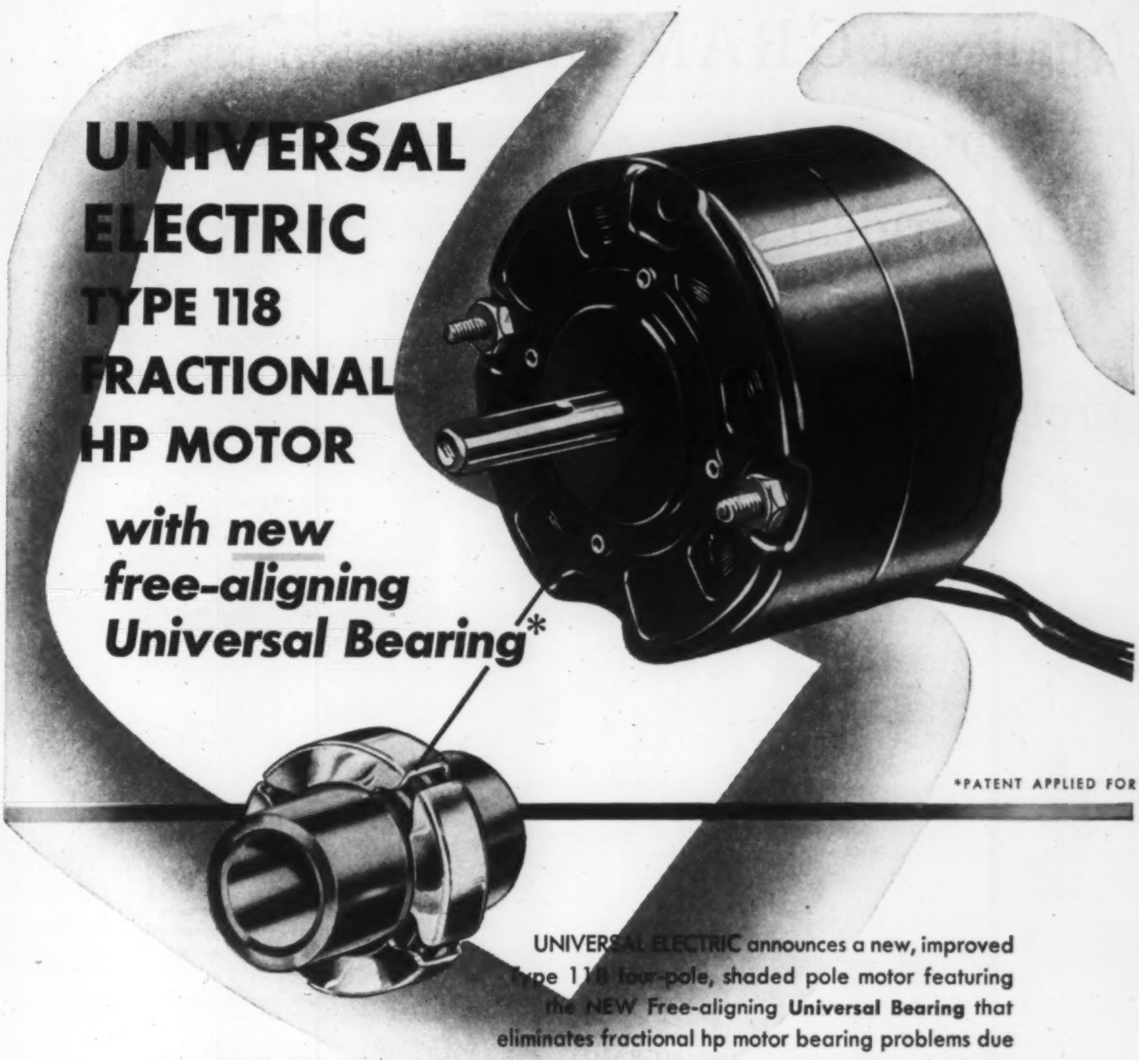
...it had to be Stainless



In this new one-handle mixing faucet all the important working parts are made of wear-resistant, corrosion-proof Carpenter stainless steels. Once you select stainless steel by Carpenter, you can forget about corrosion. You can design for high stresses, disregard maintenance problems, stop worrying about temperature variations and be assured that fabrication will be easy. And you not only get the help of consumer-acceptance of stainless products, but also the long experience of Carpenter. From the lab work through final production, Carpenter staffmen have the knowledge and the data. Call your Carpenter representative for the engineering information on stainless that you need. The Carpenter Steel Company, 120 W. Bern Street, Reading, Pa.

Carpenter STEEL

The Carpenter Steel Company, Main Office and Mills, Reading, Pa.
Alloy Tube Division, Union, N. J.
Carpenter Steel of New England, Inc., Bridgeport, Conn.
Webb Wire Division, New Brunswick, N. J.



UNIVERSAL ELECTRIC TYPE 118 FRACTIONAL HP MOTOR

*with new free-aligning Universal Bearing**

*PATENT APPLIED FOR

UNIVERSAL ELECTRIC announces a new, improved Type 118 four-pole, shaded pole motor featuring the NEW Free-aligning **Universal Bearing** that eliminates fractional hp motor bearing problems due to misalignment. With the axis of support in the center rather than at the end, and utilizing only the shaft itself for alignment, the new bearing is inherently in balance and can adjust to any shaft misalignment 100% of the time under any load conditions. The new bearing assembly provides longer bearing life, better lubrication . . . makes the Type 118 an easier starting motor that runs without a whisper of sound. More rugged and precision built from highest quality materials, the Type 118 is ideal for an unlimited number of applications that require maximum dependability with a minimum of maintenance, including kitchen ventilators, tape recorders, unit heaters, refrigeration equipment, window fans, record players, pump units, etc.

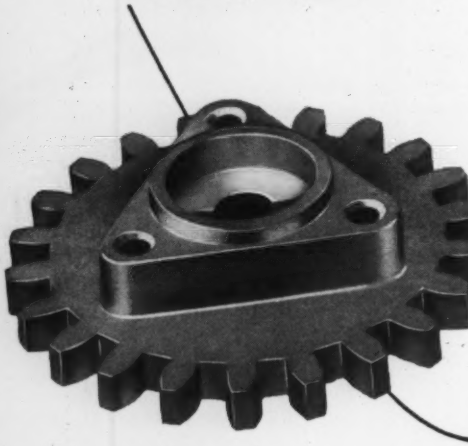
Write for complete information on the UNIVERSAL ELECTRIC Type 118 fractional H.P. motor and the new free-aligning **Universal Bearing.**

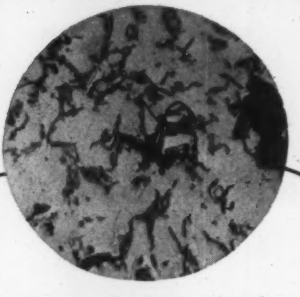
UNIVERSAL ELECTRIC COMPANY
PRECISION ELECTRIC MOTORS
EXECUTIVE AND GENERAL SALES OFFICES: OWOSSO, MICHIGAN, DEPT. 10

Circle 499 on Page 19

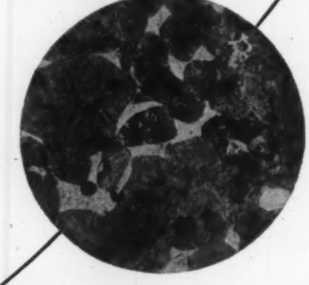
Quality of GRAMIX® precision parts insured by metallurgical control in the laboratory

proven by performance on the job!





Photomicrograph of a section of an inferior powder metallurgy part that has been improperly sintered. Structure is composed of cementite and ferrite.



Photomicrograph of an internally sound GRAMIX part shows the fine grain structure of tough, shock-resistant pearlite.

To assure the dependable performance of GRAMIX powder metallurgy parts in actual operation, the United States Graphite Company combines exacting laboratory tests and rigid production controls to insure the quality of every GRAMIX part. Through the use of the metallograph, for example, GRAMIX engineers can check the internal structure of a part. A comparison of the photomicrographs shown above readily shows the sound under-the-surface quality of a GRAMIX part as opposed to the poor internal composition of an improperly sintered part. In the photomicrograph at the top, notice the cementite between the ferrite grain boundaries. This cementite will tend to break up and rupture under shock. The surface of the material is decarburized and only remnants of pearlite remain. *This condition is due entirely to the lack of adequate sintering control!*

The photomicrograph of the GRAMIX part at the bottom shows a fine grain pearlite structure that's tough, strong and wear resisting. Absolute sintering control along with precise metallurgical control in the laboratory is utilized by The United States Graphite Company to positively assure quality GRAMIX parts.

Write today for these helpful engineering manuals. Engineering Bulletin No. 18 covers design and metallurgical requirements and alloy selection of GRAMIX bearings. No. 19 contains facts about GRAMIX Machine Parts and No. 21 contains general information on GRAMIX products from Powder Metallurgy. Get your copies now.

GRAMIX
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MACHINE
PARTS
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X-264-1R

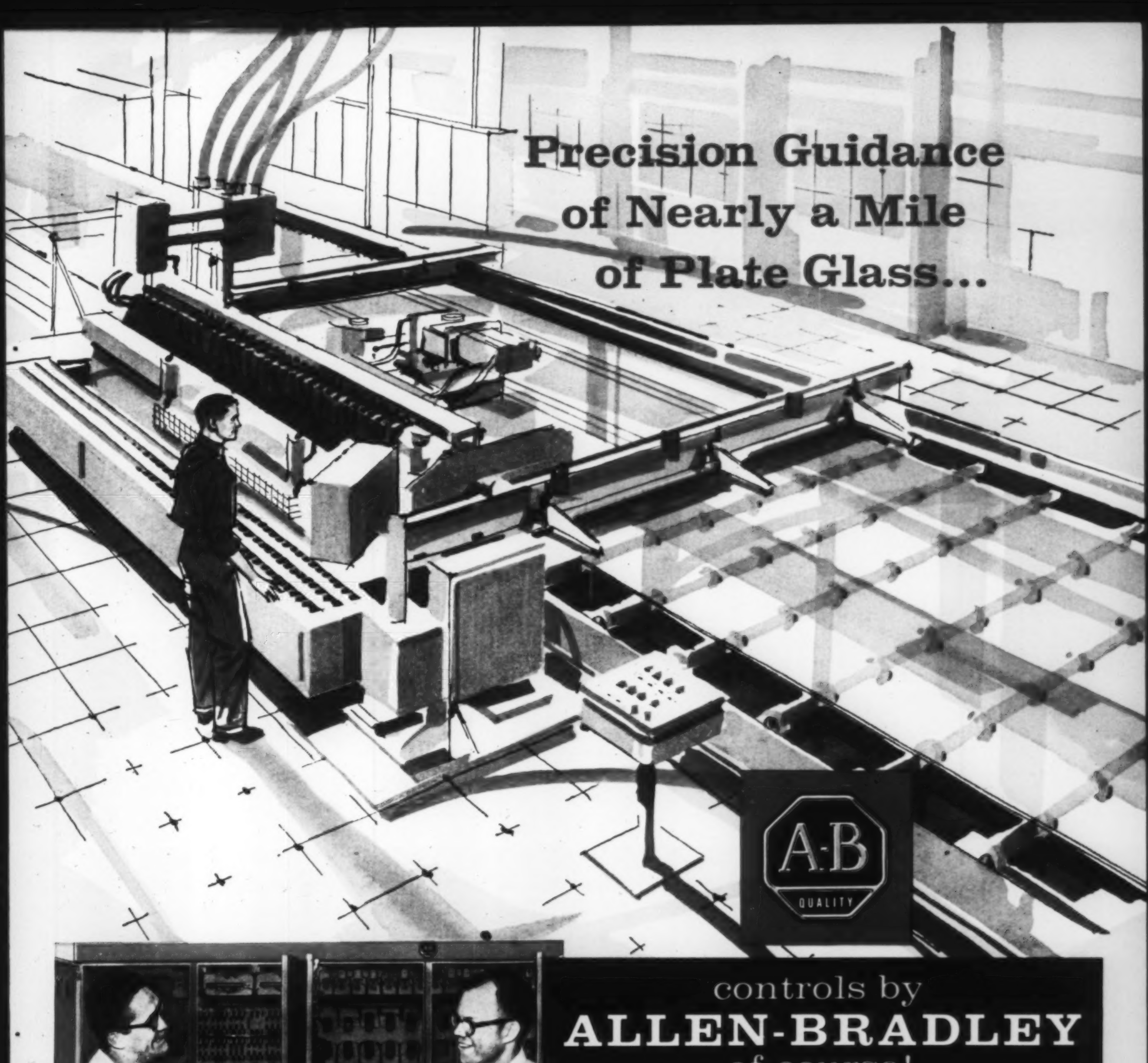
THE UNITED STATES GRAPHITE COMPANY

DIVISION OF THE WICKES CORPORATION, SAGINAW 7, MICHIGAN

GRAPHITAR® CARBON-GRAPHITE • **GRAMIX®** POWDER METALLURGY • **MEXICAN®** GRAPHITE PRODUCTS • **USG®** BRUSHES

Please direct inquiries to advertiser, mentioning MACHINE DESIGN

Circle 500 on Page 19→



Precision Guidance of Nearly a Mile of Plate Glass...

A series of control panels such as this is used in the Pittsburgh Plate Glass cutting room. Above are shown the Allen-Bradley engineers after completing the factory testing of the final panel.

controls by ALLEN-BRADLEY of course!

The New Pittsburgh Plate Glass Plant at Cumberland, Maryland, heralds a new era in the art of plate glass making. Night and day, a continuous ribbon of glass is fed to a nearly mile-long process line. Then a complex control system directs the automatic cutting, sorting, and conveying of the glass to six areas, according to a continuously varying program.

Special control panels which integrate portions of this equipment into a unified, smoothly operating system were designed, developed, and engineered by Allen-Bradley. You can benefit by this extensive control experience . . . it is a "plus" value when you specify Allen-Bradley *quality* motor control.

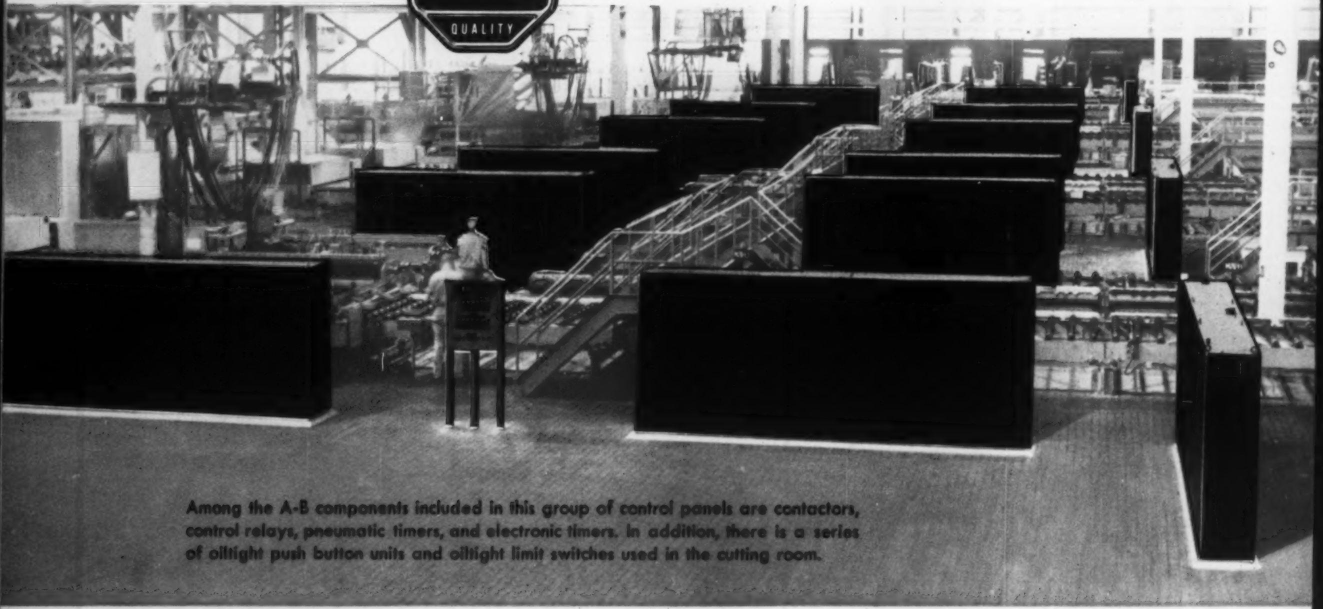
Allen-Bradley Co., 1316 S. Second St.
Milwaukee 4, Wis.
In Canada: Allen-Bradley Canada Ltd., Galt, Ont.

See on the next page how A-B Controls do it . . . →

5-59-MR

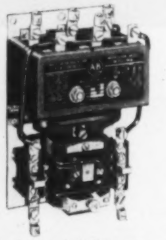
Plate Glass made by the mile with reliable ALLEN-BRADLEY Controls

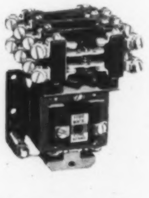
In the cutting room at Pittsburgh Plate Glass (below), Allen-Bradley controls prove the reliability of their "simple design." All A-B solenoid starters, contactors, and relays have only ONE moving part . . . assuring *millions* of trouble free operations. There are *no* bearings or jumpers to cause trouble. Contact maintenance is also eliminated—A-B double break, silver alloy contacts remain in perfect operating condition until completely worn away. Insist on Allen-Bradley *quality* motor controls . . . you cannot do better!


Among the A-B components included in this group of control panels are contactors, control relays, pneumatic timers, and electronic timers. In addition, there is a series of oiltight push button units and oiltight limit switches used in the cutting room.

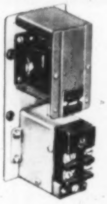
Some of the standard components which are used in this plant

Contactor—Bulletin 702, Size 3 shown. Made up to Size 8, rated 1350 amps, 220-550 v.

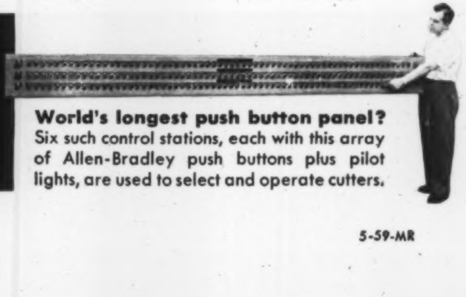

Solenoid Starter Bulletin 709, Size 2 shown. Made in ratings to 450 hp, 220v; 900 hp, 440-550 v.


Control Relay—Bulletin 700. Universal type relay with both N.O. and N.C. contacts shown.

Limit Switch—Bulletin 802T. Oiltight roller lever type shown. Also with many other operators.


Pneumatic Timer Bulletin 849 for on-delay or off-delay. Range from 1/20 to 180 sec ±10%.

ALLEN-BRADLEY
Quality Motor Control


World's longest push button panel? Six such control stations, each with this array of Allen-Bradley push buttons plus pilot lights, are used to select and operate cutters.

Allen-Bradley Co., 1316 S. Second St., Milwaukee 4, Wis.
In Canada: Allen-Bradley Canada Ltd., Galt, Ont.

5-59-MR

MACHINE DESIGN

April 16, 1959

The Lost Decade

SOMEONE said statistics are numbers with chips on their shoulders. Statistics on almost 200,000 engineers in the 1958 EJC report, *Professional Income of Engineers,* are no exception. They are fuel that can fire many a debate.

But the chips on some of the numbers are hard to knock off. The numbers are those for the men who endured the vicissitudes of the great depression. These fellows can prove that their salaries have not kept pace.

On a curve of annual salary versus years since bachelor degree, a rough dip occurs in the region of 1925 to 1935. The really bad-luck squad of 1930-34 is, today, not as well paid as 1935-39 graduates. Only men in the upper salary decile of these classes show a small margin over younger men, but even this curve falters badly from 1925 to 1935.

How much is the depression in the curve costing these men? The severest annual penalty for graduating in the lost decade ranges from $200 at the lower decile, through $400 at the median, to $1200 at the upper decile. This is the penalty in 1958. Past annual "losses" have probably been smaller, future ones may be greater. Lifetime loss could range from $6000 to $30,000.

Why should this group be special victims? The easy answer is merely to blame the depression. But why do the effects continue even after 30 years?

Speculation leads to some possible explanations. In the depth of the depression, many an engineer pumped gas, picked apples, or sold door-to-door before he got a crack at his first engineering job. Hence, today he may have no more engineering experience and value than the man who graduated several more-fortunate years later.

Or, did the traditional American "raise" system batter him? If he had the good fortune to find engineering work in 1932, he started low and in his initial years enjoyed only minor salary increases, if any. Later on, adjustments at a common percentage lifted him from a base not much different from that of the man who came on the job several years later. Despite more job maturity, his salary-curve slope was the same as that of his juniors.

Is this phenomenon only a curiosity—or does it make a point? At least it re-emphasizes a principle: Salary administration should guarantee reward for performance. It's the ordinate that counts, not the slope.

Ben Hummel

ASSOCIATE MANAGING EDITOR

What engineers should know about

Research and Development

By JOHN V. E. HANSEN
Contracts Manager
National Research Corp.
Cambridge, Mass.

PROPOSALS for research and development work are really bids to solve engineering and scientific problems for the Government. An invitation by a government agency for R & D proposals may result in technical presentations ranging from a rehash of old ideas to extremely unique, but sometimes impractical, new approaches. Cost estimates of such proposals can vary by a factor of 10 or more from proposal to proposal.

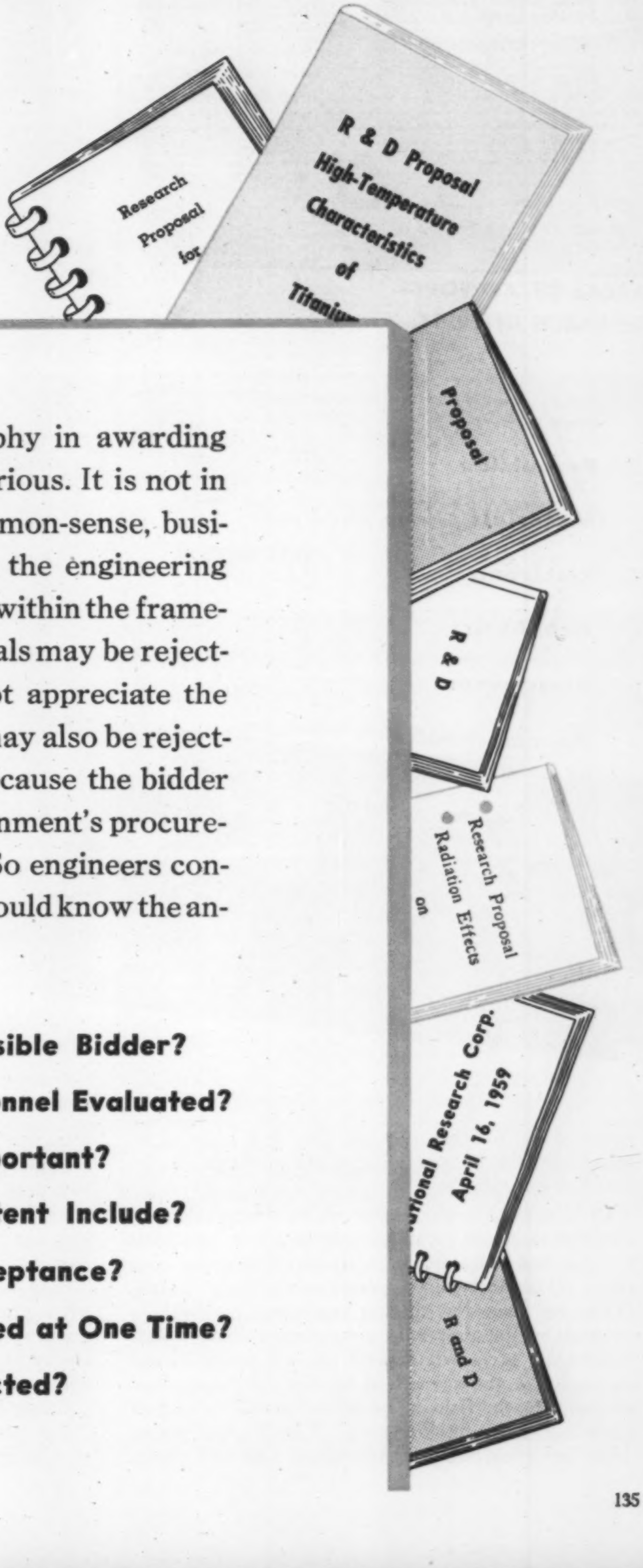
The evaluation of technical proposals by Government agencies imposes a formidable task upon the reviewers. Rules for evaluating R & D proposals are best summarized in the Government's own words: "The contract shall be awarded to that responsible bidder whose bid, conforming to the Invitation to Bids, will be most advantageous to the Government, price and other factors considered."

Bidder Reputation: The preceding statement of policy by the Government deserves reading several times, because virtually every word in it conveys meaning in excess of what might appear at first glance. For example, there is quite a bit to that "responsible bidder." Basically, a "responsible bidder" is "one who is a manufacturer or regular dealer and is financially and otherwise able to perform the contract, and is otherwise qualified and eligible by law." The primary factors in determining whether or not a bidder is responsible can therefore be established with some certainty.

A factor often considered first by the procuring agency is the reputation of the bidder. How has he managed his previous contracts, if any? Has he been prompt — and shown foresight — in dealing with problems of a contract-administration nature? Does he seem to exhibit an attitude of willing compliance with regulations, or does he frequently run afoul of the rules? How has he produced on previous contracts? Has he really come up with significant developments? Even if he has been notably unsuccessful in licking tough technical problems, has he made the most of his efforts so that other projects may benefit to the fullest from his data, conclusions, and recommendations?

Facilities and Personnel: The next problem is evaluating the qualifications of the bidder in terms of his facilities and general readiness to tackle the program. Does he have adequate facilities in terms of special equipment and space required to do the job? This does not mean that proposals including facility or equipment costs are doomed. As a matter of policy, the Government will not disqualify a bidder for lack of facilities if his proposal is

Proposals


Research
Proposal
for
R & D Proposal
High-Temperature
Characteristics
of
Titaniu
Proposal
R & D
Research Proposal
Radiation Effects
on
ational Research Corp.
April 16, 1959
R and D

The Government's philosophy in awarding R & D proposals is not mysterious. It is not in any way arbitrary. It is a common-sense, business-like method of procuring the engineering and scientific services required within the framework of our laws. R & D proposals may be rejected because the bidder does not appreciate the technical problem fully. They may also be rejected, or certainly jeopardized, because the bidder does not understand the Government's procurement policies and restrictions. So engineers concerned with R & D proposals should know the answers to these questions:

Who's Considered a Responsible Bidder?

How Are Facilities and Personnel Evaluated?

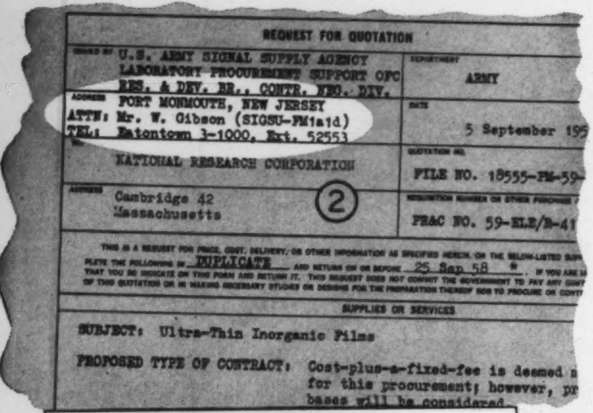
Is Proposal Appearance Important?

What Should Technical Content Include?

How Does Price Affect Acceptance?

Can Several Bids Be Submitted at One Time?

On What Bases Are Bids Rejected?



REQUEST FOR QUOTATION

ISSUED BY U.S. ARMY SIGNAL SUPPLY AGENCY
LABORATORY PROCUREMENT SUPPORT OFC
RES. & DEV. BR., CONTR. ENG. DIV.

DEPARTMENT ARMY

ADDRESS FORT MONMOUTH, NEW JERSEY
ATTN: Mr. W. Gibson (SIGSU-FM1a1d)
TEL: Eatontown 3-1000, Ext. 52553

DATE 5 September 195

TO NATIONAL RESEARCH CORPORATION

QUOTATION NO. FILE NO. 18555-FM-59-

ADDRESS Cambridge 42
Massachusetts

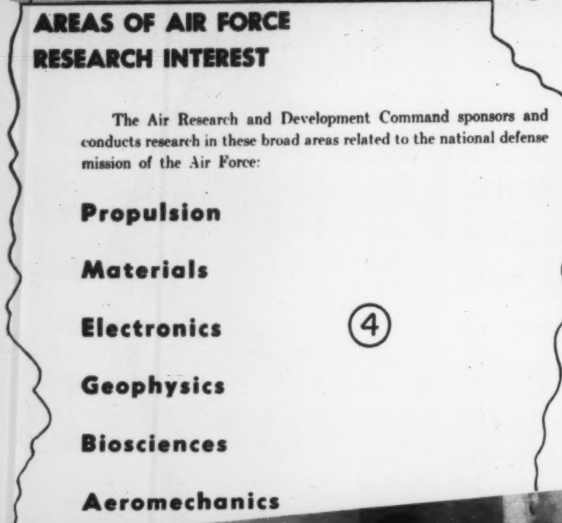
REQUISITION NUMBER OR OTHER PURCHASE PRAC NO. 59-ELE/R-41

THIS IS A REQUEST FOR PRICE, COST, DELIVERY, OR OTHER INFORMATION AS SPECIFIED HEREIN, ON THE BELOW-LISTED SUP
PLETE THE FOLLOWING IN DUPLICATE AND RETURN ON OR BEFORE 25 Sep 58 *. IF YOU ARE
THAT YOU SO INDICATE ON THIS FORM AND RETURN IT. THIS REQUEST DOES NOT COMMIT THE GOVERNMENT TO PAY ANY COST
OF THIS QUOTATION OR IN MAKING NECESSARY STUDIES OR DESIGNS FOR THE PREPARATION THEREOF NOR TO PROCURE OR CONT

SUPPLIES OR SERVICES

SUBJECT: Ultra-Thin Inorganic Films

PROPOSED TYPE OF CONTRACT: Cost-plus-a-fixed-fee is deemed
for this procurement; however, pr
bases will be considered



AREAS OF AIR FORCE RESEARCH INTEREST

The Air Research and Development Command sponsors and conducts research in these broad areas related to the national defense mission of the Air Force:

Propulsion

Materials

Electronics

Geophysics

Biosciences

Aeromechanics

R & D Proposal

Do's

1 Read the invitation carefully.

2 Contact both administrative personnel (buyer) and technical contact (project engineer) to resolve any questions.

3 Keep up to date on all related problems which may affect your proposal.

4 Keep up to date on other problems facing the agency involved to present proposals having maximum attraction.

5 Remember that the technical portion of the proposal is of prime importance and should receive maximum attention.

6 Include resumes of personnel contemplated for assignment to program and, when possible, make definite commitments of personnel.

7 Use graphic aids to simplify presentation, i.e., photographs of facilities, bar graphs of time schedules, etc.

8 Remember that the proposal is the sole basis for deciding the award of the contract; make it clear, complete and consistent with the invitation.

9 Mail completed invitation forms together with proposal.

10 Mail the proposal in time. Remember that proposals sent by registered mail, because of security regulations, may take more time in transit than nonregistered mail.

outstanding in other respects; this is a point often misunderstood by small organizations eager to obtain R & D contracts.

Incidentally, it is a policy of the Department of Defense to place a fair proportion of its contracts for supplies and services with small business concerns. The immediate question might be asked, "Does he have any specific experience in the field covered by the proposal, or in related fields?" The answer, in part, will depend on the record of the contractor at the agency. If he has completed other contracts in the field in question, he will be judged according to his performance. If he has performed other contracts well in related or identical areas for other agencies, he should mention this.

Does he have *available* personnel of sufficient technical caliber to do the job well? The Government has shown signs of tightening up on bidders who list the resumes of many highly qualified professional personnel, and who, it later turns out, cannot make the personnel available for the work when the contract is awarded. In one large program, contractors were requested to specify the availability of personnel in terms of the per cent of each man's time.

Other factors often considered in determining the "responsibility" of a bidder are the general background and achievements of his technical organiza-

R & D Proposal

Don'ts

1 Prepare a proposal without having planning session with your administrative and technical personnel.

2 Contact agency personnel to obtain information that would destroy competitive aspects of procurement.

3 Forget that technical contact has no authorization to change invitation terms. All such changes must be in writing from the agency.

4 Assume that time extensions can be granted readily.

5 Offer technical approaches that depart from the program requested.

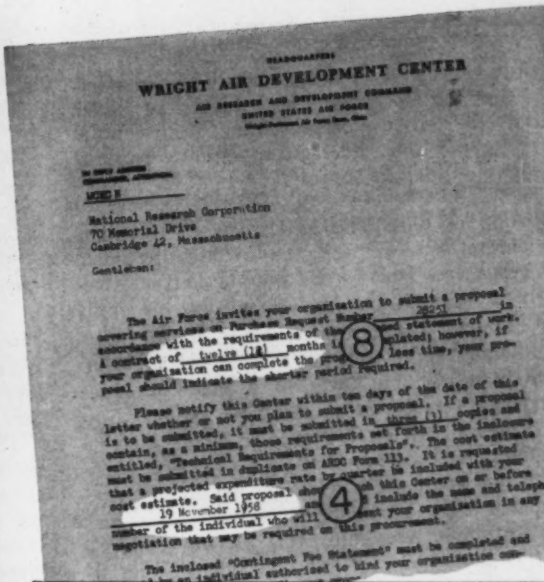
6 Offer alternate proposals.

7 Propose a program whose scope is in excess of that requested.

8 Propose a program having a period of performance in excess of that requested.

9 Qualify proposals with special provisions that may conflict with existing procurement regulations.

10 Overdo "window dressing" in proposals.



HEADQUARTERS
WRIGHT AIR DEVELOPMENT CENTER
AIR RESEARCH AND DEVELOPMENT COMMAND
UNITED STATES AIR FORCE
Wright-Patterson Air Force Base, Ohio

IN REPLY ADDRESS
COMMANDER, ATTENTION:
[illegible]

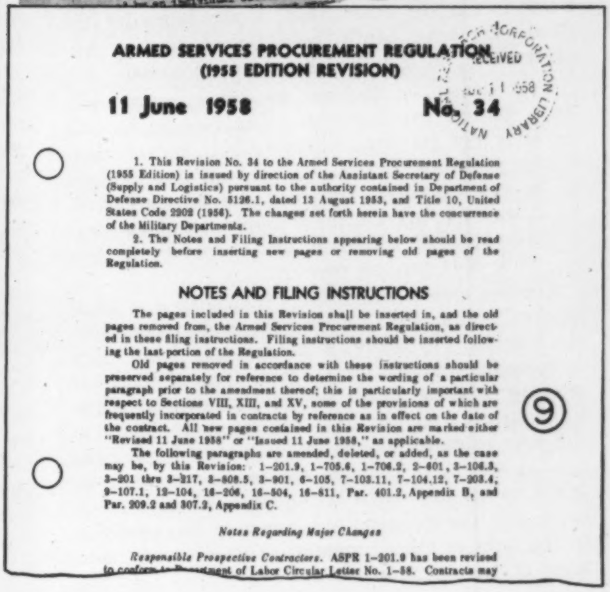
National Research Corporation
70 Memorial Drive
Cambridge 42, Massachusetts

Gentlemen:

The Air Force invites your organization to submit a proposal covering services on Purchase Request Number 28251 in accordance with the requirements of the ⑧ [illegible]ed statement of work. A contract of twelve (12) months i[illegible]plated; however, if your organization can complete the pro[illegible] less time, your proposal should indicate the shorter period required.

Please notify this Center within ten days of the date of this letter whether or not you plan to submit a proposal. If a proposal is to be submitted, it must be submitted in three (3) copies and contain, as a minimum, those requirements set forth in the inclosure entitled, "Technical Requirements for Proposals". The cost estimate must be submitted in duplicate on ARDC Form 113. It is requested that a projected expenditure rate by quarter be included with your cost estimate. Said proposal sho④[illegible]ch this Center on or before 19 November 1958 an[illegible] include the name and telephone number of the individual who will [illegible]ent your organization in any negotiation that may be required on this procurement.

The inclosed "Contingent Fee Statement" must be completed and



ARMED SERVICES PROCUREMENT REGULATION
(1955 EDITION REVISION)

11 June 1958 No. 34

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1. This Revision No. 34 to the Armed Services Procurement Regulation (1955 Edition) is issued by direction of the Assistant Secretary of Defense (Supply and Logistics) pursuant to the authority contained in Department of Defense Directive No. 5126.1, dated 13 August 1953, and Title 10, United States Code 2202 (1956). The changes set forth herein have the concurrence of the Military Departments.

2. The Notes and Filing Instructions appearing below should be read completely before inserting new pages or removing old pages of the Regulation.

NOTES AND FILING INSTRUCTIONS

The pages included in this Revision shall be inserted in, and the old pages removed from, the Armed Services Procurement Regulation, as directed in these filing instructions. Filing instructions should be inserted following the last portion of the Regulation.

Old pages removed in accordance with these instructions should be preserved separately for reference to determine the wording of a particular paragraph prior to the amendment thereof; this is particularly important with respect to Sections VIII, XIII, and XV, some of the provisions of which are frequently incorporated in contracts by reference as in effect on the date of the contract. All new pages contained in this Revision are marked either "Revised 11 June 1958" or "Issued 11 June 1958," as applicable.

The following paragraphs are amended, deleted, or added, as the case may be, by this Revision: 1-201.9, 1-705.6, 1-706.2, 2-401, 3-106.3, 3-201 thru 3-217, 3-808.5, 3-901, 6-105, 7-103.11, 7-104.12, 7-203.4, 9-107.1, 12-104, 16-206, 16-504, 16-811, Par. 401.2, Appendix B, and Par. 209.2 and 307.2, Appendix C.

⑨

Notes Regarding Major Changes

Responsible Prospective Contractors. ASPR 1-201.9 has been revised to conform to Department of Labor Circular Letter No. 1-58. Contracts may

tion. These are usually indicative of his interests and company policies, as well as his ability to work in new and varied areas.

New Versus Old Bidders: Beyond the general abilities and facilities of the bidder in terms of equipment and personnel, the words "manufacturer or regular dealer" deserve some attention. Basically, the criterion here is a satisfactory record of doing business in the field in question. If the organization is new, such information is obviously unavailable. The Government will then attempt to satisfy itself by a more thorough review of the personnel in the organization, its backing, and other factors demonstrating ability to perform the work required on the contract. If the bidder is unable to satisfy the Government, his bid could be rejected.

Similarly, the Government does have the right to reject a bid if the bidder's financial resources are considered inadequate ("and is financially . . . able to perform the contract"). This does not mean that a contractor has to have adequate capital to finance a lengthy project while waiting to be reimbursed for his work. The Government does honor monthly billings on cost-plus-fixed-fee contracts (usually written for R & D work), but when the contractor's obligations or other commitments are such as to raise doubts about his solvency, an otherwise attractive bid may be refused. Experience has shown that the Government will advise the bidder if this is the only factor preventing award of the contract, giving the bidder an opportunity to show other areas of financial support.

Rejection of Bids: The next item worth noting is the phrase, "conforming to the Invitation to Bids." Here is one area where a bid may be lost, and frequently is, without the bidder realizing his error.

For example, a bidder often thinks of two basically different approaches to a technical problem. Rather than combine them in a single proposal (concurrent attacks on a technical problem are quite common in R & D work), he decides that he will submit separate proposals. This is particularly likely if one approach is relatively low in cost, and the other is high. The bidder adopts an "across-the-board" attitude, reasoning that if the agency's budget is small, his low-cost approach will be attractive. On the other hand, if the funds for the fiscal year have hardly been tapped (a very unlikely case), he may sell his deluxe proposal.

In a moment of madness, he may even speculate upon getting two contracts. The fact is, he will probably not get one. Alternate bids, unless specifically permitted by the request, are usually held to be nonresponsive, and may not be considered. In at least one agency, there simply is a flat ruling: Unless requested, alternate bids are nonresponsive, i.e., both bids will be rejected.

Another area where bidders frequently run afoul of the "conforming" requirement is deviation from the request. Typically, a bidder may learn of a forthcoming request for proposal from a technical man in a Government agency. If the invitation subsequently received does not seem to adhere to the knowledge he gained in his informal conversation at the agency, he is apt to bid on what he heard, rather than what is requested. He may never know that the technical man's request was modified in the light of other programs or needs before issuance of the invitations—until he learns that the contract was awarded elsewhere, for the work as requested.

Technical personnel preparing a proposal may inject a few embellishments—pet approaches, research not directly related to the problem at hand, etc.—or simply expand their thinking to include areas not specifically requested. The usual result of such action is a bid that represents a deviation from what is requested. This does not imply that the Government turns a cold shoulder on new ideas. To the contrary, as mentioned earlier, the very purpose of R & D proposals is to stimulate new ideas. However, when such ideas either fail to meet the requirements or otherwise detract from the performance of the work, they may be rejected.

Looking at it from a purely administrative standpoint, rather than from a technical view, deviations from bids put the evaluating agency in an awkward position. If the contract is awarded to a bidder who has not complied with the request, the agency is, in effect, discriminating against bidders who played the game by the rules.

Appearance and Content: The final words of the award policy, ". . . will be most advantageous to the Government, price and other factors considered," are perhaps the most sweeping.

The phrase, "advantageous to the Government," obviously covers a multitude of factors. The item of primary importance, however, is the technical superiority of the proposal. All the resumes, annual reports, leather-bound covers, and three-color overlays in a proposal have little effect on the evaluator's opinion of the technical presentation.

The bidder must demonstrate two points: 1. That he understands the problem fully. 2. That he has an approach (or approaches) that is well thought out and which shows signs of promise if executed as described.

In such a contest, there is considerable merit to new and revolutionary ideas that offer the possibility of significant scientific breakthroughs. However, even old, well-established approaches have won contracts. This is particularly true where the reasons for the previous failure of these approaches are analyzed, and it is shown that there are still areas in such approaches that have not been adequately investigated.

Evaluating the Invitation: The question of understanding the problem fully is much more important than most people realize. All too often, bidders apply knowledge and experience to the description of the problem in the request for proposal without looking further. This description is usually brief. The Government encourages discussion with its technical personnel in such instances, and such discussions may reveal entirely new and pertinent information, either from classified work previously unknown to the contractor, or from work currently being performed in other Government agencies.

In line with this practice of encouraging bidders to make the fullest use of Government information, the Government frequently holds bidders' conferences after invitations for proposals have been issued. Such meetings are invaluable in orienting the bidder who has been out of touch with either the agency or its problems for any length of time. They also serve to clarify and expand the usually terse description of the problem in the invitation.

There are even more subtle aspects to "understanding the problem." The agency team evaluating proposals from a technical standpoint will, as a matter of course, include the technical personnel originating the request for proposals. Such personnel are closest to the problem at hand, and are valuable sources of information for other work currently or recently performed in the area in question. More important, however, is their opinion of such work.

For example, assume that an invitation has been issued for research and development leading to high-strength, high-temperature materials for a specific application. A certain R & D organization may come up with three possible approaches: 1. A high-temperature coating on high-strength material. 2. An alloy composed of rare metals. 3. A polymeric material. During a technical discussion with personnel of the agency, the bidder may learn that there is not much attraction for coatings in general. The reasons may not all be apparent, and to be sure, it is possible the bidder may never appreciate this opinion. However, at this point, common sense dictates appreciation of the opinion of personnel who have been working closely with the problem for months or years.

A clear understanding of the ultimate needs of the agency will also assist the bidder in evaluating the worthiness of his approaches. If the long-range plans for the material in question are such that there will be a great demand, then what will be the effect of an approach based on material that is in very short supply? In many instances, such questions have been anticipated by the agency, and they may be in a position to tell the bidder whether or not the resources of the metals he proposes in his second approach will be such as to rule them out for the ultimate use. The bidder may also find that the agency itself has done some preliminary work with the alloy the bidder had in mind, and may have some very definite ideas about it.

Other aspects of the agency's work and needs often color the reception a proposal meets. The bidder's third approach may have some very definite merit for the immediate need. However, he may be able to ascertain that the agency has some hopes that the material developed under this program may be useful in another application, and the polymer alone—as opposed to the first two approaches—stands a good chance of filling this need. This certainly makes the third approach attractive.

It may appear that the absence of these various factors and requirements in a request for proposal is unfair. This is plainly not so, if the situation is considered from the Government's standpoint. If the bidder is qualified and is active in the field in question, he should be aware of the latest developments in the field. If he understands the problem fully, he would not propose an approach that is impractical because of a shortage of the starting materials. Such factors would seriously detract from a proposal.

A solution that also answers needs in other areas enhances the proposal. The bidder would certainly not be disqualified for failing to provide such a double-barreled solution, but it is reasonable that such a solution would be much more attractive to the Government.

The argument that such other needs are not known to bidders may be true, but there are methods of obtaining such information—even beyond the routine of establishing and maintaining a close rapport with the agency, and thus being aware of its needs. The Air Force, for example, in its Technical Program Planning Document program, spells out its needs in considerable detail. Information in some areas may be classified, but is available to potential bidders who qualify. Other agencies make similar efforts to keep potential contractors interested and informed.

Cost Factors: In the preparation of proposals, there remains one big area for discussion—price. Admittedly, although the Government does say "price and other factors considered," price will play a large role in the picture. Once a bidder has come to appreciate the restrictions of Government regulations and the intricacies of Government budget and finance, his life will be somewhat simpler.

If bids for a one-year program are requested, for example, the bidder who feels the necessity for an extended program and therefore submits a bid for a three-year program will be disappointed. The Government cannot contract for a period beyond which funds have been appropriated, and therefore a "three-year or nothing" attitude will mean no contract. At best, the bidder will have to settle for a one-year contract, as the invitation specified, with the distinct possibility that he will be awarded additional contracts if his performance and the Government's needs warrant it.

In a similar sense, a bidder who proposes a $5 million contract to a department whose entire budget is $6 million is usually making a mistake, unless he has ascertained that this is the order of magnitude the agency envisioned in sending out the invitations. In fairness, it must be pointed out that agencies have, on occasion, requested invitations for work without fully realizing the cost. Such instances are avoided, when possible, by spelling out the level of effort in the invitations, i.e., three man-years.

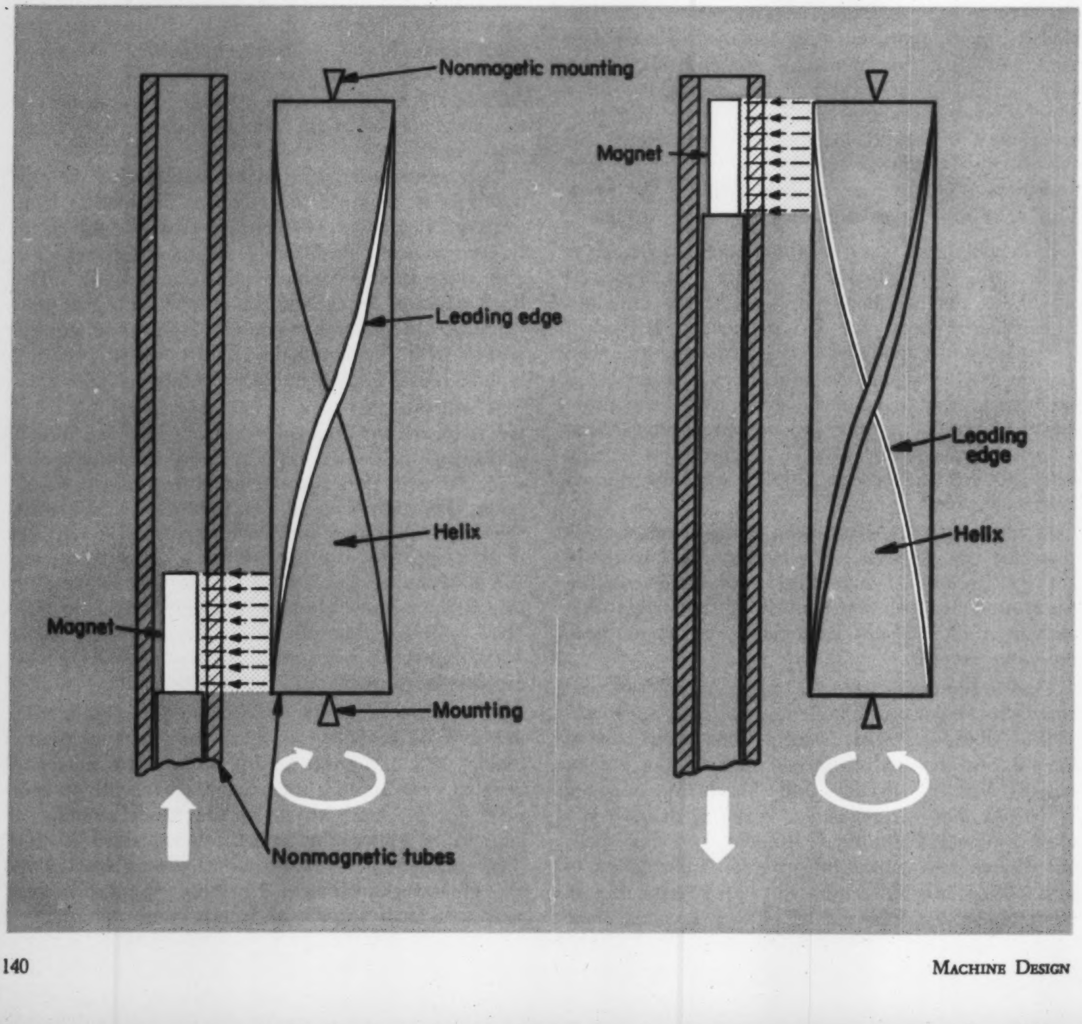
The common practice in evaluating R & D proposals is to separate the technical evaluation from the cost evaluation. Separate personnel with separate responsibilities initially evaluate each section, and make their recommendations accordingly. The final decision is usually then reached in a joint meeting. In general, technical evaluations are reported with the acceptable bidders listed in order of preference. Unacceptable proposals are identified.

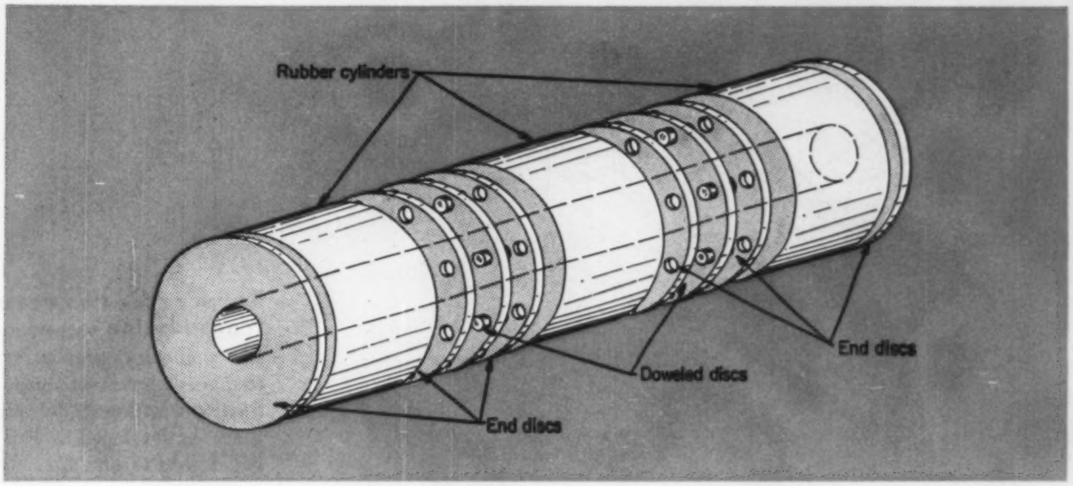
It will probably be a unique day in the annals of Government procurement when the order of acceptability of proposals from a technical standpoint coincides with their attractiveness from a cost standpoint. Experience has shown that all too frequently the most attractive technical approach is not the most competitive price-wise, and then there are compromises to be made. Either the outstanding superiority of the most technically acceptable proposal will warrant the expenditure of the additional funds, or a less attractive but still technically acceptable proposal will be selected.

Each case must be decided on its own merits, but it must be borne in mind that, with a limited budget and a number of interesting programs and problems confronting an agency, there will be considerable incentive to make the funds stretch. A supporting philosophy sometimes expressed is that "the greater the number of programs underway, the greater the chances for some singular success that will justify increased future appropriations."

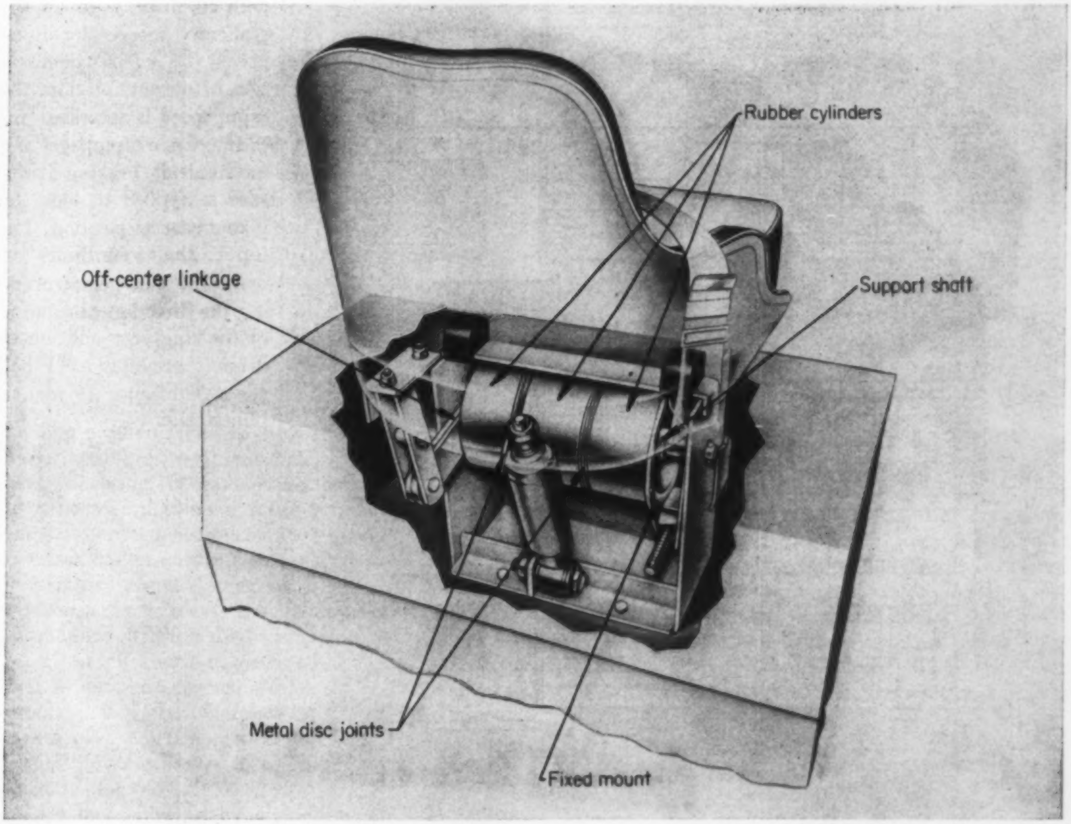
scanning the field for *ideas*

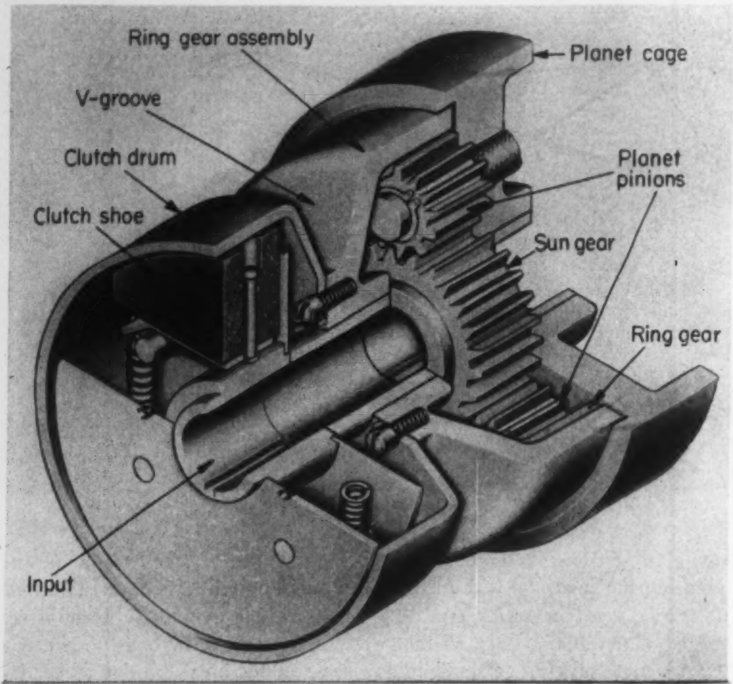
Magnetic drive for instrument or low-power applications converts linear to rotary motion without mechanical connection. An iron strip, formed into a helix, is encapsuled in a nonmagnetic tube which is fixed in position but free to rotate. The helix assembly is located parallel to a nonmagnetic tube which contains an Alnico magnet embedded in the end of a rod. As the rod is moved linearly, the magnet constantly attracts the leading edge of the helix, imparting a rotary motion to the helix assembly. As employed by Brooks Rotameter, this principle is used to indicate flow rate in a rotameter.

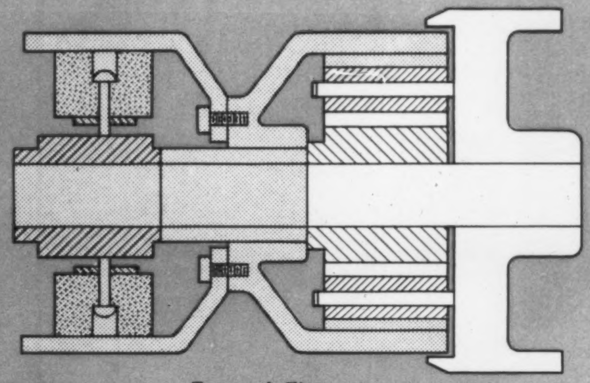

Nonmagetic mounting
Leading edge
Helix
Magnet
Mounting
Nonmagnetic tubes
Magnet
Leading edge
Helix

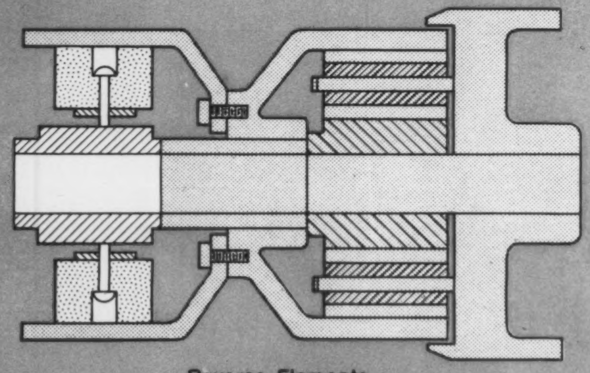

Rubber cylinders
Doweled discs
End discs
End discs

Sandwiched rubber cylinders in a long torsion spring assembly absorb high-impact loads and provide rapid recovery characteristics. Used in a seat suspension system developed by Caterpillar Tractor Co., three rubber cylinders, with metal discs on the ends of each, are aligned horizontally on a shaft and the assembly is fixed at one end. The seat is connected to the opposite end of the assembly through an off-center linkage system. A metal disc, with metal dowel rods through it, is inserted between the end discs on the rubber cylinders during assembly so that the dowels mate with holes in the end-discs. The doweled sections break up the rubber cylinder length to prevent collapse and transmit torque from one rubber section to another for even absorption of impact loads.


Rubber cylinders
Off-center linkage
Support shaft
Metal disc joints
Fixed mount




Forward Elements


Reverse Elements

Forward - reverse transmission uses standard planetary gear-set to change direction of output rotation without shifting gears. As developed by Fairbanks, Morse and Co., the power train is made up of a centrifugal clutch keyed to the input shaft, a clutch drum and ring-gear assembly which also forms the V-groove for the output belt, a sun gear keyed to the input shaft, and an external brake-drum assembly which carries the planet pinions. With the brake released, engagement of the clutch with its drum locks-up the planetary gear-set for direct drive. To reverse the direction of output rotation, the input speed is decreased until the clutch disengages and mechanical braking pressure is applied to lock the planet cage in position. The input shaft continues to drive the sun gear, reversing the direction of rotation of the ring gear and clutch drum assembly (V-belt sheave) through the planet-pinion idlers.

Plagued with bimetal problems like

High deflection and low force?

Low deflection and high force?

Small temperature change?

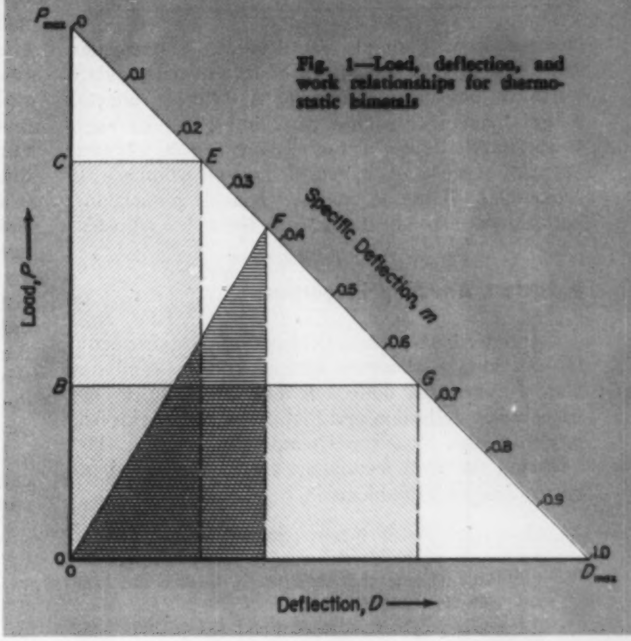


Fig. 1—Load, deflection, and work relationships for thermostatic bimetals

Solve them by designing . . .

Maximum-Work Bimetals

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Detroit

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Royal Oak,
Mich.

IN MANY applications of thermostatic bimetal elements, capacity of the bimetal for performing mechanical work is of first-order importance. Whether the element must pick up a weight, compress a spring, operate a member against friction, or otherwise develop a force and move it through some distance, mechanical work is involved and influences design of the element.

A rather common practice in the development of bimetal-actuated devices is to design the operating mechanism first and then try to fit a bimetal element to the application. In such cases, load, deflection, and temperature change are generally specified. The problem, then, becomes one of designing a bimetal element of practical proportions and of minimum volume for the lowest cost. This is always achieved by adjusting the dimensions of the element. Techniques for achieving bimetal elements of minimum volume were presented in a previous article.*

In some cases, where original performance specifications of the bimetal-actuated device are exacting, the element so designed will be disproportionate. It may be too long to fit the available space, or it may be so thin that it lacks mechanical ruggedness and stability, or it may be too thick for required forming and stamping operations (excessive thickness also leads to slower response to thermal transients), or it may be so short and wide that it will not perform according to theory and is subject to inaccuracies from mounting effects. These problems can be overcome by several methods outlined in this article.

For example, the type of bimetal element can be changed from a simple cantilever to a triangular cantilever to take advantage of its greater capacity for work per unit volume, or a different bimetal material having a higher work index can be used, or specific deflection of the element can be adjusted (at the expense of increased bimetal volume). If these methods fail to improve bimetal proportions, performance specifications can then be adjusted.

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*C. F. Alban and C. C. Perry—"Thermostatic Bimetal Elements," MACHINE DESIGN, Vol. 29, No. 4, February 21, 1957, p. 119.

▶ Factors Affecting Proportions

Disproportionate bimetal elements most frequently arise from applications which require a combination of very high deflection and low force, or extremely low deflection and high force, to be achieved, in either case, by a small temperature change. The following remedial techniques are recommended for overcoming such problems:

1. Change the design (where possible) of the operating mechanism of the bimetal-actuated device to reduce the work requirements and more nearly balance the force and deflection specifications.
2. Increase the temperature change available to perform the action.
3. Select the most suitable type of thermostatic bimetal material.
4. Select the optimum element type (straight cantilever, trapezoidal cantilever, simply supported beam, U-shaped element, coil, etc.) for the application.
5. Adjust specific deflection to bias the performance of the element (at a premium in increased volume) in the direction of the unbalanced force and deflection requirements.

These adjustments are demonstrated in the sample problem.

Specific Deflection: Work produced by a bimetal element as the temperature is changed from T_1 to T_2 depends upon the mode of operation; that is, upon the load-deflection characteristics of the installation. Fig. 1 illustrates the relationship between load and deflection for a bimetal. For any particular temperature change, the final operating condition of the bimetal can be represented by a point on the diagonal line which has, for convenience, been scaled in units of m, the specific deflection.

Nomenclature

A = Rotation, deg (coils)
b = Width, in.
D = Deflection, in. (strips)
K_{DC} = Deflection constant (coils)
K_{DS} = Deflection constant (strips)
K_{PC} = Torque constant (coils)
K_{PS} = Torque constant (strips)
L = Length, in.
m = Specific deflection
P = Force or load, oz
Q = Geometric factor for trapezoidal beams
r = Radius to point of load application, in. (coils)
ΔT = Temperature change, deg F
t = Thickness, in.
U = Stiffness coefficient for trapezoidal beams
W = Work, in.-oz

Bimetal operating conditions change from those at the origin to those represented by a point on the diagonal in the P-D plane. Mechanical work output is the area under this path. For example, complete restraint of the bimetal element merely allows the operating point to travel up the ordinate. In this instance, deflection is zero and there is, of course, no area under the curve and therefore no work done. It can also be seen that with free deflection, the operating point moves outward along the abscissa from the origin but, since no force is developed, the area under the curve and the work are again zero.

Note that the discussion here is restricted to those cases which involve development of a force with temperature change, and the calculations for work do not include the effects of static, unchanging preloads. If, for example, a horizontal cantilever-mounted bimetal strip has a dead weight suspended from its free end, subsequent temperature change will cause a corresponding change in deflection precisely equal to the free deflection of that element, and independent of the weight, as long as the maximum allowable stress is not exceeded. Thus, the superposition theorem common to beam-analysis methods conveniently permits separate treatment of initial mechanical loading and thermally developed loads. Only the thermally developed loads are considered here.

▶ Types of Bimetal Elements

Bimetal elements which are designed to pick up gravity loads, overcome set preloads, or develop the force to operate against a constant resistance will product, in the P-D plane, rectangular work areas such as those delineated under paths OCE and OBG, Fig. 1 A constant-rate spring load produces a triangular work area such as that under OF. It is apparent that for any final operating point on the diagonal line, maximum work will be done in reaching that point if the operating path outlines a rectangular work area (except, of course, for over-center spring arrangements).

Simple Cantilever Bimetal Elements: For the constant-load case, magnitude of work is equal to the product PD. From the generalized force and deflection equations for cantilever thermostatic bimetal elements (see Nomenclature),

$$P = \frac{K_{PS} K_{DS} \Delta T\, b t^2 (1 - m)}{L} \quad (1)$$

$$D = \frac{K_{DS} \Delta T L^2 m}{t} \quad (2)$$

$$W = PD = K_{PS} K_{DS}^2 (\Delta T)^2 b t L (1 - m) m \quad (3)$$

Equation 3 demonstrates that the mechanical work output of a thermostatic bimetal is proportional to

$K_{PS}K_{DS}^2$ (henceforth referred to as the work index, a fundamental property of the bimetal material), the square of the temperature change, the volume of the bimetal element, and a function of m, the specific deflection. Further study of the equation reveals that mechanical work is zero when m is either zero or unity, corresponding to conditions of complete restraint or free deflection, respectively, and confirms the previous conclusions deduced from the P-D diagram. Variation of the m-function with m is shown in Fig. 2. Maximum mechanical work occurs at $m = 0.5$, as can readily be proven by differentiating Equation 3 with respect to m and setting the result equal to zero.

Similarly, for applications in which the bimetal deflects a constant-rate spring with temperature change, the P-D work area equals $PD/2$, and,

$$W = \frac{K_{PS}K_{DS}^2(\Delta T)^2 btL(1-m)m}{2} \tag{4}$$

Since the numerical factor of ½ is independent of m, differentiation of this work equation produces the same result as before; that is, for maximum work, m should be equal to 0.5. It can also be shown that for nonlinear springs having load-deflection characteristics expressible by a relationship of the form $P = KD^N$, where K and N are constants, a specific deflection of 0.5 will still be required for maximum work. It should be noted that for a particular force and deflection requirement, and specific deflection, the volume of bimetal necessary to perform the task is the same regardless of the path in the P-D plane. That is, the same volume will be necessary whether the element develops and moves a constant force a given distance or compresses a spring to the same maximum force in the same distance.

Bimetal Coils: In a manner parallel to the preceding, the mechanical work capacity of bimetal coils can be obtained:

$$P = \frac{K_{PC}K_{DC}\Delta T bt^2(1-m)}{r} \tag{5}$$

$$A = \frac{K_{DC}\Delta T Lm}{t} \tag{6}$$

$$W = PD, \text{ but } D = Ar\frac{2\pi}{360}$$

Therefore,

$$W = 0.01742 K_{PC}K_{DC}^2(\Delta T)^2 btL(1-m)m \tag{7}$$

Equation 7 is similar to Equation 3, and the two can be compared for absolute magnitude since there are at least theoretical relationships between K_{PC} and K_{PS}, and between K_{DC} and K_{DS}, for any bimetal. For Chace thermostatic bimetals, for example,

$$K_{DC} = 125K_{DS} \qquad K_{PC} = 0.0058K_{PS}$$

Thus,

$$\frac{K_{PC}K_{DC}^2}{K_{PS}K_{DS}^2} = 0.0058(125)^2 = 88.2$$

and,

$$\frac{W_C}{W_S} = 88.2(0.01742) = 1.54$$

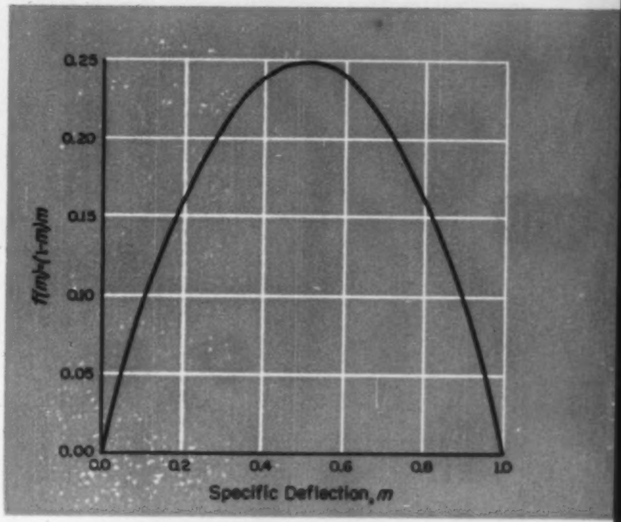


Fig. 2—Occurrence of maximum mechanical work at a specific deflection, m, of 0.5

This shows that a coil will produce approximately 50 per cent more work than a cantilever-mounted straight strip of the same active volume. In applications involving very small displacements (with no problems in converting rotary to linear motion) use of a coil instead of a straight strip could result in a measurable saving in bimetal volume if coil dimensions are within a practicable range. Production, mounting, and assembly costs of coils versus straight strips must naturally be considered in making any over-all cost comparison.

Simply Supported Beam Elements: Design situations embodying comparatively large forces and small deflections also suggest the use of a simply supported straight beam, since such a beam is an inherently high-force, low-deflection member. The generalized force, deflection, and work equations for a beam of this type are:

$$P = \frac{4K_{PS}K_{DS}\Delta T bt^2(1-m)}{L} \tag{8}$$

$$D = \frac{K_{DS}\Delta T L^2 m}{4t} \tag{9}$$

$$W = K_{PS}K_{DS}^2(\Delta T)^2 btL(1-m)m \tag{10}$$

As might be expected, capacity of the simply-supported beam for mechanical work is identical to that of a cantilever beam of the same dimensions. However, Equations 8 and 9 indicate that, other things being equal, the simply supported beam produces four times the force and one-quarter the deflection of a cantilever element.

In the quest for maximum work per unit volume, consideration should be given to the simply supported constant-strength or triangular cantilever and diamond-shaped or rhombic beams, Fig. 3. Both are characterized by uniform bending stress along their lengths when loaded as shown. In the case of the

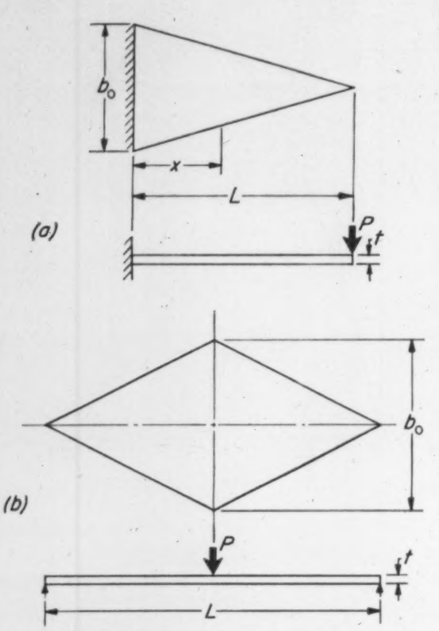


Fig. 3—Triangular, *a*, and rhombic, *b*, simply supported, constant-strength beams with nomenclature

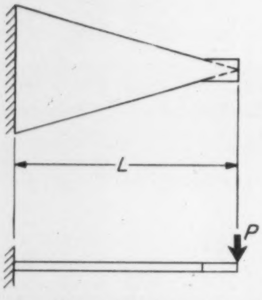


Fig. 4—Modified triangular beam with sufficient width at the free end to support a load

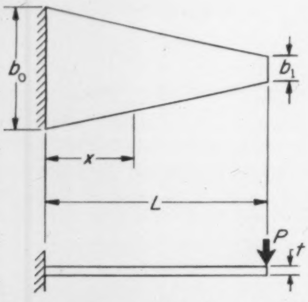


Fig. 5—Cantilever trapezoidal beam. Material savings from 0 to 25 per cent in volume are theoretically possible with this type of element

triangular planform beam with a concentrated load at the free end, both the bending moment and moment of inertia are linear functions of the distance along the beam. The result is that the ratio M/I is a constant and $\sigma = MC/I = kC = k'$. This equation is also valid for simply supported rhombic beams.

Triangular Cantilever Elements: The triangular or rhombic design is considered the optimum in efficiency where a maximum allowable stress is the limiting factor since all surface fibers are stressed to the same extent. Advantages of this design are most pronounced, however, for a beam in which all or most of the stress is due to mechanical loading. In thermostatic bimetals, a portion of the stress is generated by differential expansion of the component metals. Since the latter effect is uniform along the length of the beam, and independent of the width, a triangular design will not modify thermal stresses. Thus, any gains to be derived from the triangular shape will be realized only with respect to mechanical loading.

In terms of free-deflection response as a thermostatic bimetal, a triangular beam theoretically has the same characteristics and produces the same deflection for a particular temperature change as a straight-sided or rectangular beam of the same length and thickness. Actually, deflections would not be exactly the same because of differences in cross curvature effects between the two types. Relationships developed in this article ignore such effects but, for precision results, experimental elements should be fabricated and tested before going into production. The generalized force, deflection, and work equations for a triangular cantilever element are:

$$P = \frac{0.667 K_{PS} K_{DS} \Delta T\, b_0 t^2 (1 - m)}{L} \tag{11}$$

$$D = \frac{K_{DS} \Delta T\, L^2 m}{t} \tag{12}$$

$$W = 0.667\, K_{PS} K_{DS}^2 (\Delta T)^2 b_0 t L (1 - m) m \tag{13}$$

Here, the work capacity is two-thirds that of a rectangular beam of the same length and thickness, but the work per unit volume is 33 per cent greater than for the corresponding rectangular beam. Other generalities previously derived remain unaffected. For example, specific deflection of the triangular beam should still be 0.5 for a bimetal element of minimum volume. From a practical viewpoint, the gain in work per unit volume to be realized from using a triangular beam is slightly less than that calculated here because of the necessity of providing sufficient width at the free end of the beam to support the load. An actual beam might have an appearance as shown in Fig. 4, the modified contour producing only a very small effect on stiffness.

Trapezoidal Cantilever Elements: As a compromise alternative, a trapezoidal beam can be employed,

Fig. 5. Force, deflection, and work capacity for such a beam are

$$P = \frac{K_{PS}K_{DS}\Delta T\, b_0 t^2(1-m)}{3UL} \tag{14}$$

$$D = \frac{K_{DS}\Delta T L^2 m}{t} \tag{15}$$

$$W = \frac{K_{PS}K_{DS}^2(\Delta T)^2 b_0 t L(1-m)m}{3U} \tag{16}$$

where U is the stiffness coefficient for trapezoidal beams. Values are taken from Fig. 6 and are functions of the ratio of beam proportions:

$$Q = 1 - \frac{b_1}{b_0}$$

For $Q = 0$, $U = 0.333$, and the trapezoidal beam becomes a rectangle, while Equations 14, 15, and 16 reduce to Equations 1, 2, and 3. When $Q = 1$, $U = 0.50$, and the beam is a triangle, with Equations 14, 15, and 16 simplifying to Equations 11, 12, and 13. The coefficient U is plotted in Fig. 6 for all values of Q from zero to unity.

Equation 16 demonstrates that as Q varies from zero to unity, and U from 0.333 to 0.50, the work capacity of the trapezoidal beam varies from that of the straight-sided rectangular beam to that of the triangular beam. Thus, any volume saving from zero to 25 per cent is theoretically possible.

Simply Supported, Double-Trapezoidal Elements: A double-trapezoidal beam, Fig. 7, can be used in applications involving a large force and small deflection. For such a beam

$$P = \frac{4K_{PS}K_{DS}\Delta T\, b_0 t^2(1-m)}{3UL} \tag{17}$$

$$D = \frac{K_{DS}\Delta T L^2 m}{4t} \tag{18}$$

$$W = \frac{K_{PS}K_{DS}^2(\Delta T)^2 b_0 t L(1-m)m}{3U} \tag{19}$$

Paralleling the straight-sided beam, the simply supported, double-trapezoidal beam develops four times the force, one-quarter the thermal deflection, and the same amount of mechanical work as a cantilever trapezoidal element of equal length and thickness.

Referring again to the generalized work Equations 3, 4, 7, 10, 13, 16, and 19, it can be seen that to obtain the utmost in mechanical work from a thermostatic bimetal element, one must select a bimetal having the maximum work index, employ the largest permissible temperature change, use the greatest practical volume, and design for a specific deflection of 0.5. The remaining parameters are not, in many design applications, subject to adjustment at will.

Generally, a specification involves predetermined load, deflection, and temperature change, with the design problem being to select the optimum bimetal type and the size, shape, and proportions of the bimetal element. However, since the total bimetal volume required for any design varies directly with thermally developed mechanical work and inversely with the square of the temperature change, attention should always be given to minimizing the work and maximizing the temperature change to minimize the volume. Fig. 8 illustrates the relationship of work, temperature change, and minimum volume, for $m = 0.5$ and a particular bimetal type, Chace No. 6650.

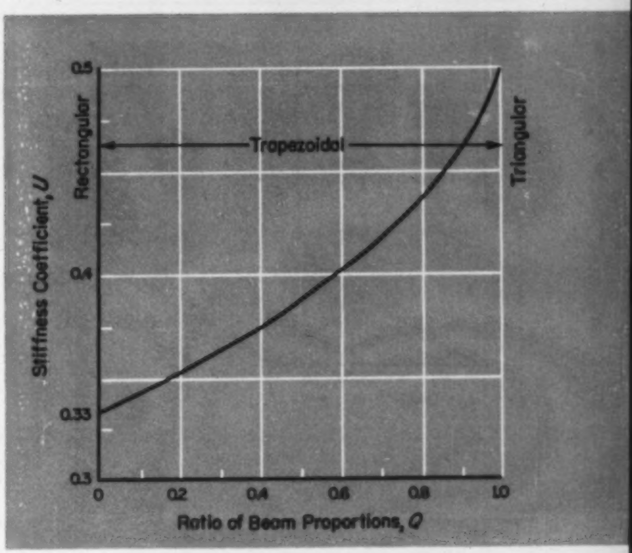


Fig. 6—Stiffness coefficients, U, for trapezoidal beams as a function of beam proportions, Q

▶ Design Examples

To illustrate design modifications made to improve proportions or reduce the volume of a bimetal element, an application involving a large force, small deflection, and small temperature change will be analyzed according to principles described.

Assume that a subminiature snap-action switch is to be operated with a bimetal. Specifications require a force differential of 1.5 oz, a movement differential of 0.0005 in., and a temperature differential of 2 deg F for actuation.

Solution 1: Since the available temperature change for switch actuation is very low, a bimetal with an extraordinar-

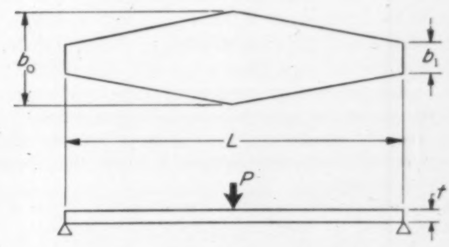


Fig. 7—Double trapezoidal beam for applications involving a large force and small deflection

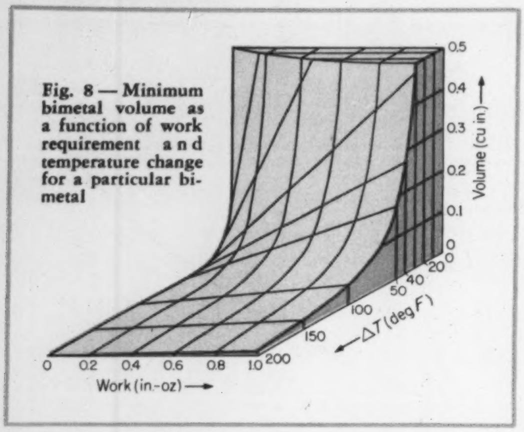


Fig. 8 — Minimum bimetal volume as a function of work requirement and temperature change for a particular bimetal

ily high work index is selected. Force and deflection constants for Chace thermostatic bimetal No. 6650 are $K_{PS} = 80 \times 10^6$ and $K_{DS} = 105 \times 10^{-7}$.

A value of 0.5 is selected for specific deflection, *m*, to minimize volume, and several arbitrary widths are substituted in Equations 1 and 2 together with known factors. Solving the equations simultaneously for each width produces a series of straight cantilever elements of varying proportions

b	*t*	*L*
⅝	0.073	1.87
¾	0.065	1.76
⅞	0.058	1.66
1	0.053	1.59
1¼	0.046	1.48

Volume of each element is approximately 0.085 cu in. All elements, however, are either too thick or too short and wide to be considered good practice. Volumes are actually exactly equal because work, temperature change, and specific deflection are the same in each case.

Solution 2: Since the problem involves a comparatively large force and small deflection, advantages of biasing the specific deflection toward zero to, say, 0.333, should be investigated. Again, for straight cantilever elements, proportions now become

b	*t*	*L*
½	0.080	2.40
¾	0.061	2.09
⅞	0.055	1.98
1	0.050	1.88
1¼	0.043	1.75

Here, the volume of each element is approximately 0.096 cu in. A slight improvement in proportions has been gained but at the expense of approximately a 10 per cent increase in bimetal volume.

Solution 3: If the magnitudes of force and deflection can be varied to bring them more nearly into balance while keeping the work requirement the same, element dimensions will be modified considerably. By increasing the deflection and diminishing the force both by a factor of ten and keeping $m = 0.5$, proportions of the elements become

b	*t*	*L*
½	0.039	4.32
¾	0.030	3.78
⅞	0.027	3.60
1	0.025	3.47
1¼	0.021	3.16

The elements, although convenient in thickness, are rather long for proper length-to-thickness ratio and optimum mechanical ruggedness. They may also be too long to fit in the allotted space. A smaller change in force and deflection can be made following the same procedure, or a U-shaped element might be investigated.

Solution 4: Assuming that force and deflection cannot be changed from the original specification, sizable gains can be realized from opening up the temperature change to, say, 4 deg F. Again, with $m = 0.5$,

b	*t*	*L*
¼	0.067	1.26
⅜	0.051	1.10
½	0.042	1.00
⅝	0.036	0.92
¾	0.032	0.87
⅞	0.029	0.83

These proportions represent a decided improvement over those of the first trial and require only one quarter of the bimetal volume. However, the elements tend to be either a little too thick or too wide and short.

Solution 5: As a final approach, the original force and deflection specifications will be retained, but a 4 deg F temperature differential will be substituted. This time, a double-trapezoidal, simply-supported beam element will be analyzed because of the inherent merits described earlier.

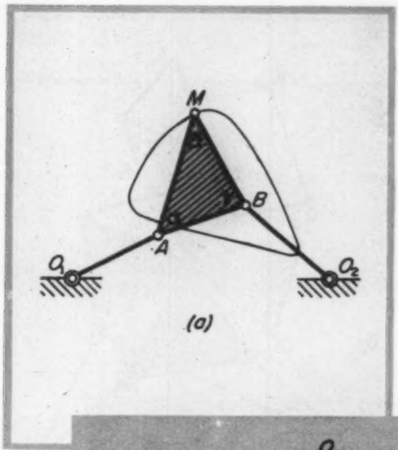
Beam proportions were selected so that the ratio $b_0/b_1 = 3$ and $Q = 0.667$. From Fig. 6, the corresponding value of *U* is 0.412. Specific deflection, *m*, remains 0.5.

By substituting all known values and arbitrary widths in Equations 14 and 15 and solving simultaneously, element proportions become

b	*t*	*L*
¼	0.049	2.16
⅜	0.037	1.88
½	0.031	1.72
⅝	0.027	1.60
¾	0.023	1.48
⅞	0.021	1.41

Here, the volume of each element is approximately 0.018 cu in. and was reduced because of the improved stress distribution in the trapezoidal beam. The elements have now assumed very practicable proportions.

These sample solutions demonstrate only a few of the techniques described in the article. Each problem, however, has its own limitations which will determine the most suitable approach to obtain a thermostatic bimetal element of minimum volume and optimum proportions.



Cognate Linkages

How to find linkages of different proportions and operating characteristics that produce the same coupler-point curve

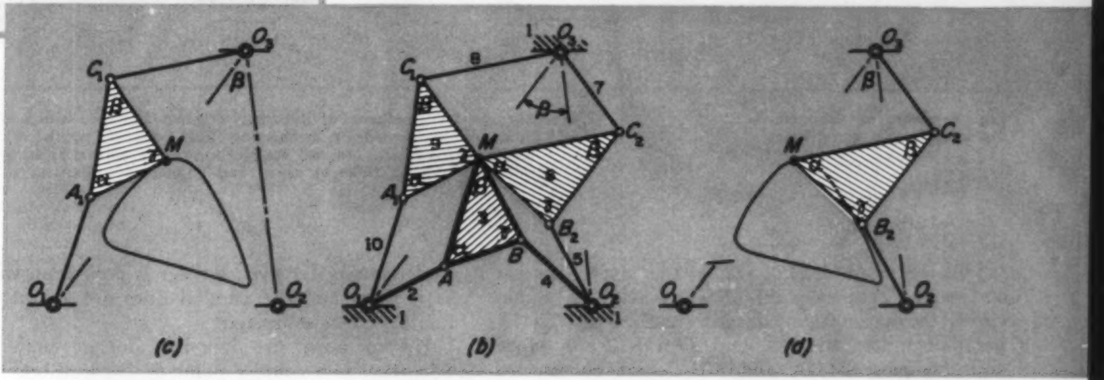


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Fig. 1—Development of four-bar cognate linkages based on the Roberts-Chebychev Theorem. Given four-bar linkage and curve of motion of coupler-point *M* are shown at *a*, construction for cognate linkages at *b*, and individual cognate four-bars at *c* and *d*. Motion curve of coupler-point *M* is the same for all three four-bar linkages.

WHEN the designer is concerned only with the curve traced by a coupler point of a planar four-bar linkage; then other planar linkages tracing an identical coupler-point curve may be found by the application of the Roberts-Chebychev Theorem. For want of a name, these linkages, which are related through their common coupler curve, will be called cognate linkages.

These linkages do not look alike. Their relation stems only from the identical coupler curves they trace. Thus, a cognate linkage may be substituted for the entire cycle of motion of its related linkage, providing in this manner a linkage whose space requirements may be more favorable than that of the linkage which it replaces. Velocity and acceleration characteristics of cognate linkages will not, in general, be identical link for link.

Roberts-Chebychev Theorem: The present literature in English does not seem to mention this useful theorem bearing the names of an Englishman and a Russian. There are a number of contemporary sources in German. Beyer[1, 2] and Bloch[3] have been drawn on for the broad aspects of this discussion.

Roberts[4] and Chebychev[5] were mathematicians of considerable stature during the latter part of the past century. Members of the Royal Society, both studied, among other things, four-bar linkages for tracing coupler-point curves. Chebychev had a particular interest in curves having approximate straight-line segments. A familiar linkage having this property is the Watt "straight-line" motion which is nearly 100 years older than the comparable Chebychev linkage. The Roberts' "straight-line" mechanism is due to an engineer, Richard Roberts of Manchester.

The French[6] and German literature speak of "Roberts' Theorem," while the dual name appears in the Russian. It seems most proper to use both names; Roberts announced his discovery in 1875, Chebychev in 1878. Except for the final result, there is no resemblance in the developments, for the approaches are as different as they can be.

The Theorem is easily stated: "There are three different planar four-bar linkages that will trace identical coupler curves." To give this statement substance, consider the construction shown in Fig. 1.

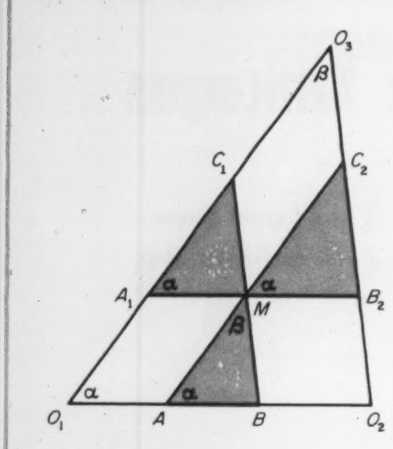

Fig. 2—Plan for determining lengths of cognate links.

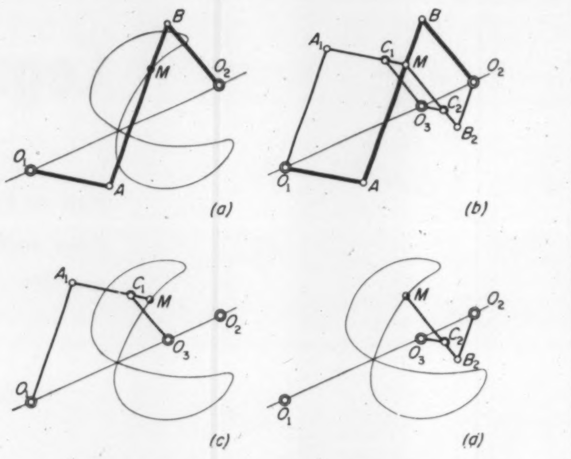

Fig. 3—Development of four-bar cognate linkages when coupler-point *M* is located on connecting link between points *A* and *B*. Given four-bar linkage and coupler curve are shown at *a*, construction for cognate linkages at *b*, and cognate four-bars at *c* and *d*.

Linkage O_1ABO_2, Fig. 1*a*, is the given four-bar and carries coupler point *M* which traces a planar curve. In the cognate-linkage construction, Fig. 1*b*, parallelograms O_1A_1MA and O_2BMB_2 are added and triangles A_1MC_1 and MB_2C_2 are constructed similar to triangle *ABM* (Note angle locations). A third parallelogram, $C_1O_3C_2M$, is then constructed to find frame point O_3. A total of three four-bar linkages which are mutually connected at coupler point *M* now can be recognized.

The entire complex of ten links, Fig. 1*b*, is movable. In fact, this ten-bar linkage is overclosed; there are two more links than necessary. Two links, such as O_1A_1 and O_2B_2, could be removed to leave eight links as a constrained mechanism.

Each of the three linkages traces an identical coupler curve through common coupler point *M*. Thus, the given four-bar could be replaced by either of the other linkages, which have different space requirements because of link lengths and one frame point location, O_3. These, then, are cognate linkages related through the common coupler-point curve.

If the Theorem is true, frame point O_3 must be truly fixed, as are points O_1 and O_2. This proof can be shown geometrically, but the construction is tedious. The simplest demonstration, making use of complex numbers, seems to be that of Schor which is given by Bloch.[8] This proof shows not only that O_3 is a fixed point, but also that triangle $O_1O_3O_2$ is similar to the coupler triangle, *AMB*.

The latter information suggests a quick method for locating point O_3. On the frame line O_1O_2, Fig. 1*b*, a triangle similar to *AMB* is constructed. Upper vertex of this triangle is point O_3.

Location of point O_3 was part of Roberts' demonstration. Cayley[7] suggested the schematic of Fig. 2. It is a simple way of determining the link lengths of the cognate mechanisms. In this construction, the given linkage is pulled out straight, as it were, and the parallel lines are drawn to define the cognate linkages.

Up to now, the four-bar linkage under consideration had coupler point *M* lying to one side of the line *AB*. The Theorem still applies when the coupler point lies on the line *AB*, either between or beyond points *A* and *B*. Determination of cognate linkages requires a bit more care now, for all of the links of Fig. 2 will now lie on top of each other, and the cognate couplers will be "lines."

As point *M* moves closer to line *AB*, the general geometry is preserved as the links approach colinearity with each other and line O_1O_2. Frame point O_3 will, in the limit, lie on line O_1O_2, but will then divide it in the same ratio as point *M* will divide line *AB*. Note that points C_1 and C_2 will divide lines A_1M and MB_2 similarly.

As an example of the condition where point *M* lies between points *A* and *B*, consider the linkage shown in Fig. 3*a*. It would be a Watt's linkage if coupler point *M* lay at the midpoint of line *AB*. From Fig. 3*b*, these facts are apparent:

1. Frame point O_3 lies on line O_1O_2, and divides it in the same ratio as point *M* divides line *AB*.
2. Line O_1A_1 is parallel to line *AM*, and line MA_1 is parallel to line O_1A, defining point A_1.
3. Line O_2B_2 is parallel to line *MB*, and line MB_2 is parallel to line O_2B, defining point B_2.
4. Point C_1 will divide line A_1M in the same ratio as point *M* divided line *AB*, allowing link C_1O_3 to be located to complete cognate linkage $O_1A_1C_1O_3$ (Fig. 3c).
5. Point C_2 will divide line MB_2 in the same ratio as point *M* divided line *AB*, allowing link C_2O_3 to be located to complete cognate linkage $O_2B_2C_2O_3$ (Fig. 3*d*).

Where point *M* lies on an extension of line *AB*,

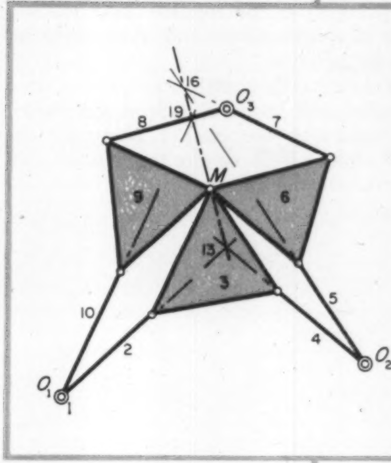

Fig. 4—Construction showing colinearity of coupler-point M and instantaneous centers of coupler and frame of each of three cognate linkages. Connecting line is normal to the coupler curve.

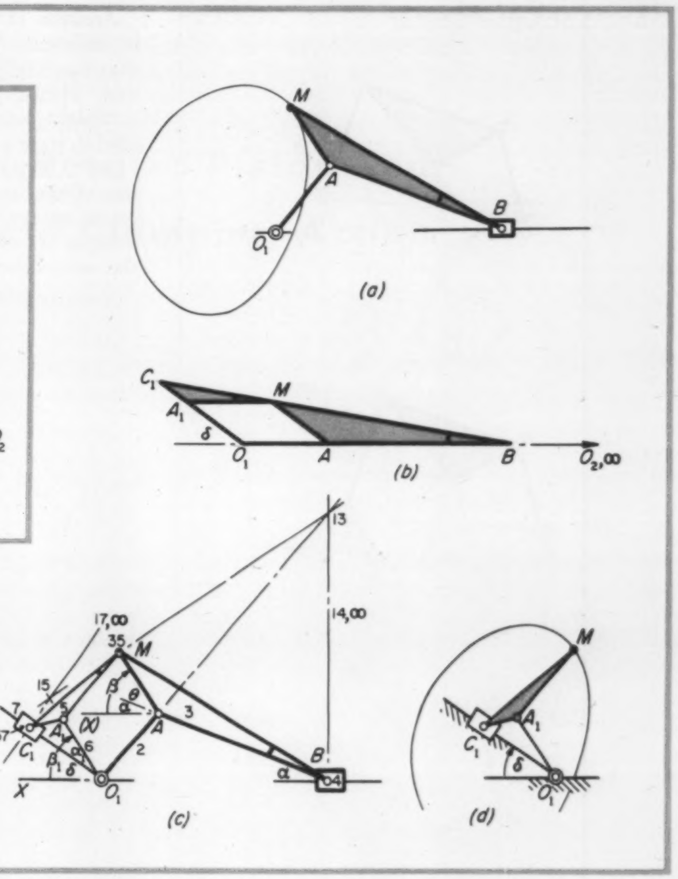

Fig. 5—Development of cognate slider-crank mechanism based on the Roberts-Chebychev theorem. Given mechanism and coupler curve are shown at *a*, plan for determining proportions of cognate mechanism at *b*, cognate construction at *c*, and the cognate slider-crank at *d*.

the routine is the same as before, except that the line "divisions" are now external, following the position of point M.

Cayley[7] showed that coupler point M and the instantaneous centers of coupler and frame of each of the three linkages are colinear at all times, and that this connecting line is the normal to the coupler curve, Fig. 4.

Velocity Relationships: In Fig. 1*b* assume that the angular velocity of link O_1A in the given linkage O_1ABO_2 is ω_2. Angular velocities of links AB and O_2B, determined in some convenient way, are ω_3 and ω_4. Since line O_1A is parallel to line A_1M, line O_3C_2 is parallel to line C_1M, and angle A_1MC_1 is fixed, the angular velocity of link O_3C_2 is also ω_2. Similar considerations are applicable to other links of the cognate linkages, and the following velocity equivalences result:

$$\omega_9 = \omega_2 = \omega_7$$

$$\omega_{10} = \omega_3 = \omega_5$$

$$\omega_8 = \omega_4 = \omega_6$$

where subscripts identify numbered links, Fig. 1*b*.

These velocity relations must be taken into account when point M is driven along the coupler curve with prescribed velocities. For example, suppose the desired motion of M is obtained from the linkage O_1ABO_2 with link O_1A driven at a constant angular velocity. The same motion of M (trajectory and velocities) will also be obtained by using cognate linkage $O_2B_2C_2O_3$ and driving link O_3C_2 at the same constant angular velocity. If the cognate linkage $O_1A_1C_1O_3$ must be used, then it will have to be driven at a variable angular velocity corresponding to the angular velocity of either link AB or O_2B when link O_1A of the given linkage is driven at the constant angular velocity.

Slider-Crank Mechanisms: The Roberts-Chebychev Theorem also applies to slider-crank mechanisms: "There are two different planar slider-crank mechanisms that will trace identical coupler curves."

If a sliding pair replaces one of the turning pairs of a four-bar linkage, a slider-crank mechanism

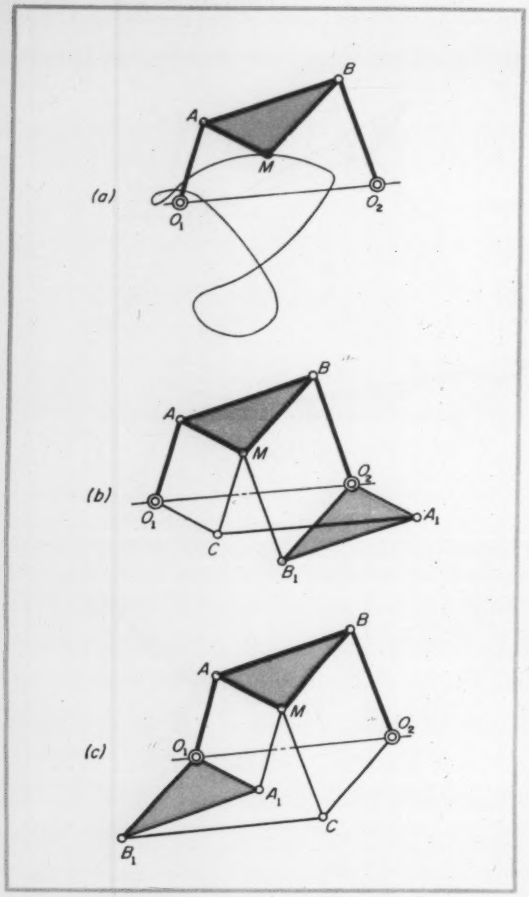

Fig. 6—Development of cognate six-bar linkages for four-bar linkage. Given four-bar and coupler curve are shown at *a*, construction of six-bar cognate linkages at *b* and *c*.

results, Fig. 5*a*. Center O_2 is at infinity, with link BO_2 now infinitely long, a somewhat impractical machine part. When this linkage is "straightened," Fig. 5*b*, only a portion of the schematic can be drawn since line BO_2 now extends to infinity at the right. Under these circumstances, the linkage "above" point O_2 vanishes, for practical purposes, and with it point O_3 finds itself at infinity. Beyond what might have been point C_1 lies point O_3 (at infinity), whence C_1 must also be a slider. However, the cognate-linkage slider-crank $O_1A_1C_1$, which shares the coupler point M with the given linkage, has been defined.

Construction of the cognate slider-crank may be followed in Fig. 5*c*. A parallelogram and a similar triangle are added as shown. Point 13 is the instantaneous center of the given coupler and frame, point 35 is the transfer center, and point 15 applies to the cognate coupler. The course of the new slider is then along the perpendicular to line 15-57 drawn through point 57.

Analysis of Fig. 5*c* shows that $\delta = \theta$, where θ is constant. This result justifies the conclusion that line O_1C_1 is a straight line of constant inclination. Hence, point C_1 of the cognate slider follows a straight path of constant slope and, thus, could be used to trace a straight line.

As with the four-bar linkage, instantaneous centers of the coupler and frame of each of the slider-crank mechanisms and the coupler point M are colinear at all times. This connecting line is also the normal to the coupler curve.

Velocity relations are:

$$\omega_2 = \omega_5$$

$$\omega_3 = \omega_6$$

$$\frac{v_{C1}}{v_B} = \frac{AM}{AB}$$

where v is linear velocity of the point identified by subscript.

Six-Bar Cognate Linkage: An extension of the Roberts-Chebychev Theorem is: "The coupler-point curve of a planar four-bar linkage is also described by the joint of the dyad of a proper six-bar linkage."

The course of this extension may be seen from Fig. 6*a*. Here, linkage O_1ABO_2 is the given four-bar which carries coupler point M. The procedure for finding the six-bar linkage is, Fig. 6*b*:

1. From points O_1 and M, construct a parallelogram locating point C.
2. From points O_2 and M construct a parallelogram locating point B_1.
3. Construct triangle $A_1O_2B_1$ similar to triangle AMB. It is reversed and upside down with respect to triangle AMB.
4. Connect points C and A_1, forming a third parallelogram $O_1O_2A_1C$.

Links MC and MB_1 are the dyad whose joint is at point M. An identical dyad is formed when the other frame point, O_2, is used, Fig. 6*c*.

If the frame parallelograms go into the antiparallelogram configuration at the change points, completely different coupler-point curves will be traced.

ACKNOWLEDGMENT

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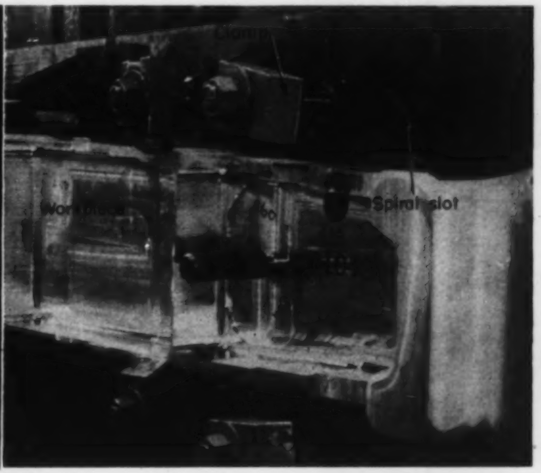
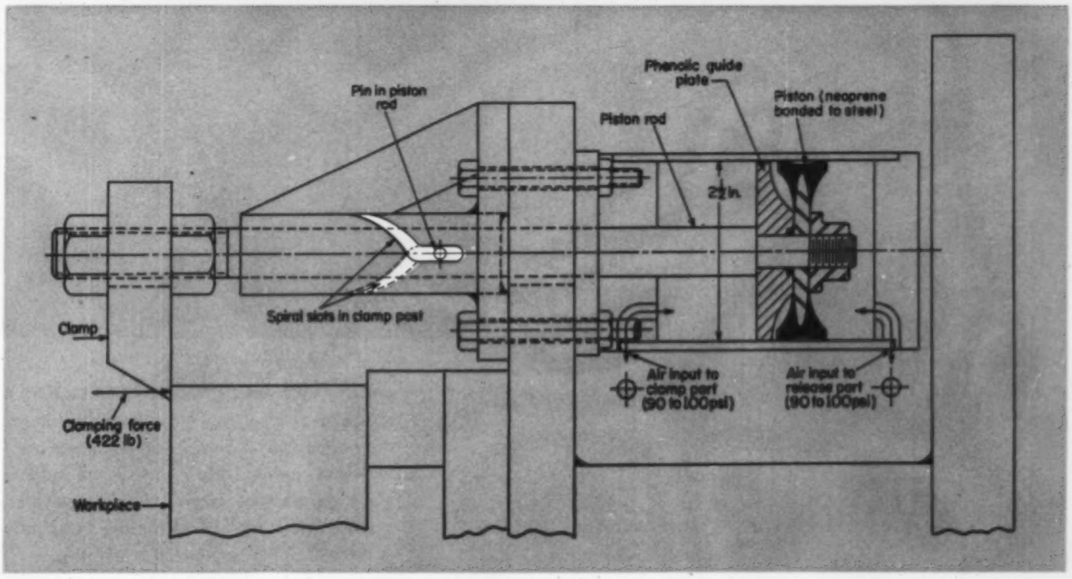
Spiral Slot Rotates Piston Rod To Facilitate Clamping Action

LINEAR-TO-ROTARY MOTION is produced in a pneumatic clamp by two spiral-shaped slots cut into opposite sides of each clamp post. Ends of a pin through the piston rod ride in these spiral slots. As air pressure is applied to the air cylinder to clamp a part, the piston rod is pulled in and twisted 90 deg. When air pressure is applied to the opposite end of the cylinder, the workpiece is released and the clamp is rotated out of the way to permit easy removal of the part.

Clamp design was developed by George Phillips, Chance Vought Aircraft Inc., Dallas, for a multiple-clamp system used to hold large aluminum alloy forgings on a Keller profiling machine. A total of 17 clamps are used in the system. Each air clamp is tightened or released by a corresponding hand valve. The clamps are color coded to match their respective control valves.

Color-coded valves


Clamp
Workpiece
Spiral slot

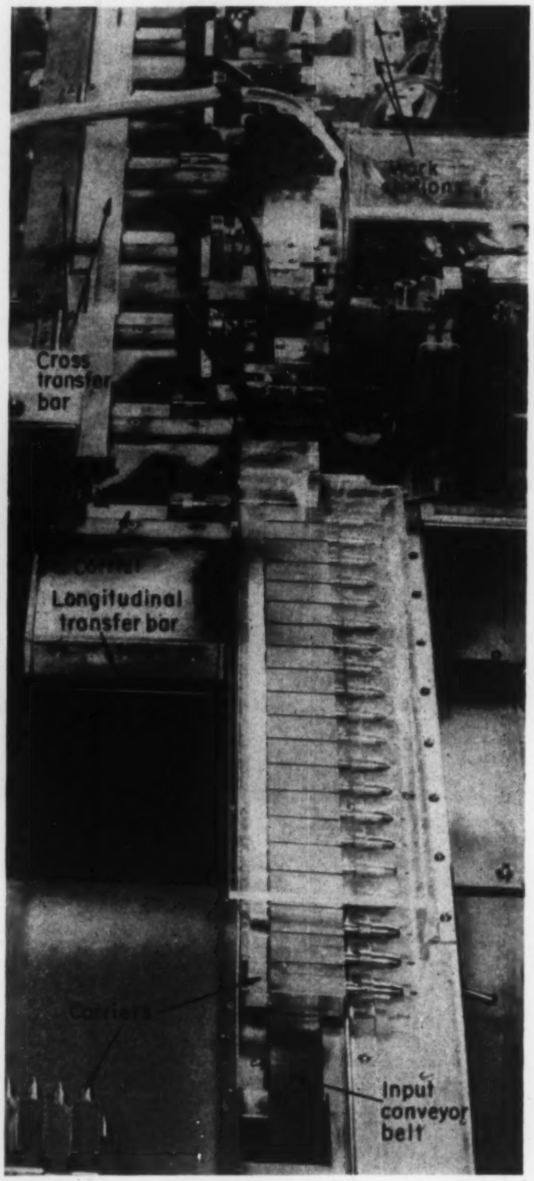

Pin in piston rod
Phenolic guide plate
Piston (neoprene bonded to steel)
Piston rod
$2\frac{1}{2}$ in.
Spiral slots in clamp post
Clamp
Clamping force (422 lb)
Workpiece
Air input to clamp part (90 to 100psi)
Air input to release part (90 to 100psi)

Parts Automatically Transferred

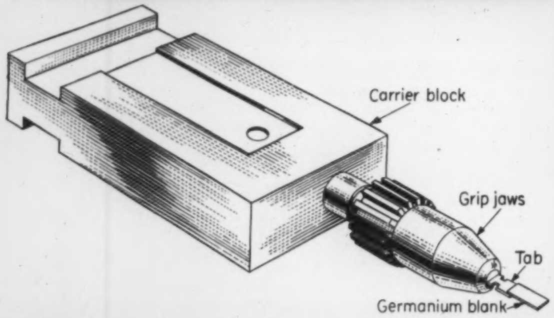
HIGH-SPEED POSITIONING of small parts is accomplished with extreme accuracy in this new automatic transistor-assembly machine. Designed as an integral part of an automation line at Philco's Lansdale Tube Co. division, this particular machine automatically etch and plates a pair of small circular pits on opposite sides of thin germanium blanks. These etched pits form the emitter and collector areas in each transistor.

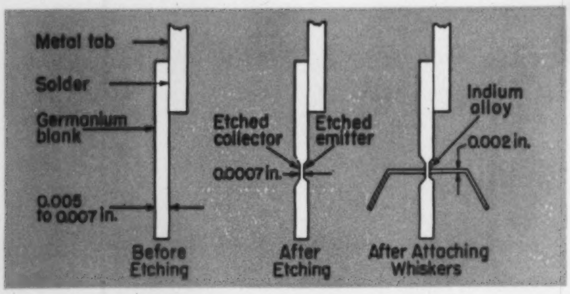
Depth, size, and location of these pits must be precisely controlled. Thickness of the germanium block is 0.005 to 0.007 in. Distance between the collector and emitter surfaces after the etching and plating sequence is 0.0007 in.

A machine in the next section of the line automatically attaches whiskers 2 mils in diameter to the emitter and collector areas by a delicate microalloying process using indium alloy.


Work stations
Cross transfer bar
Carrier
Longitudinal transfer bar
Carriers
Input conveyor belt

Output belt conveyor
Cross transfer bar
Carriers
Longitudinal transfer bar
Work stations


Carrier block
Grip jaws
Tab
Germanium blank

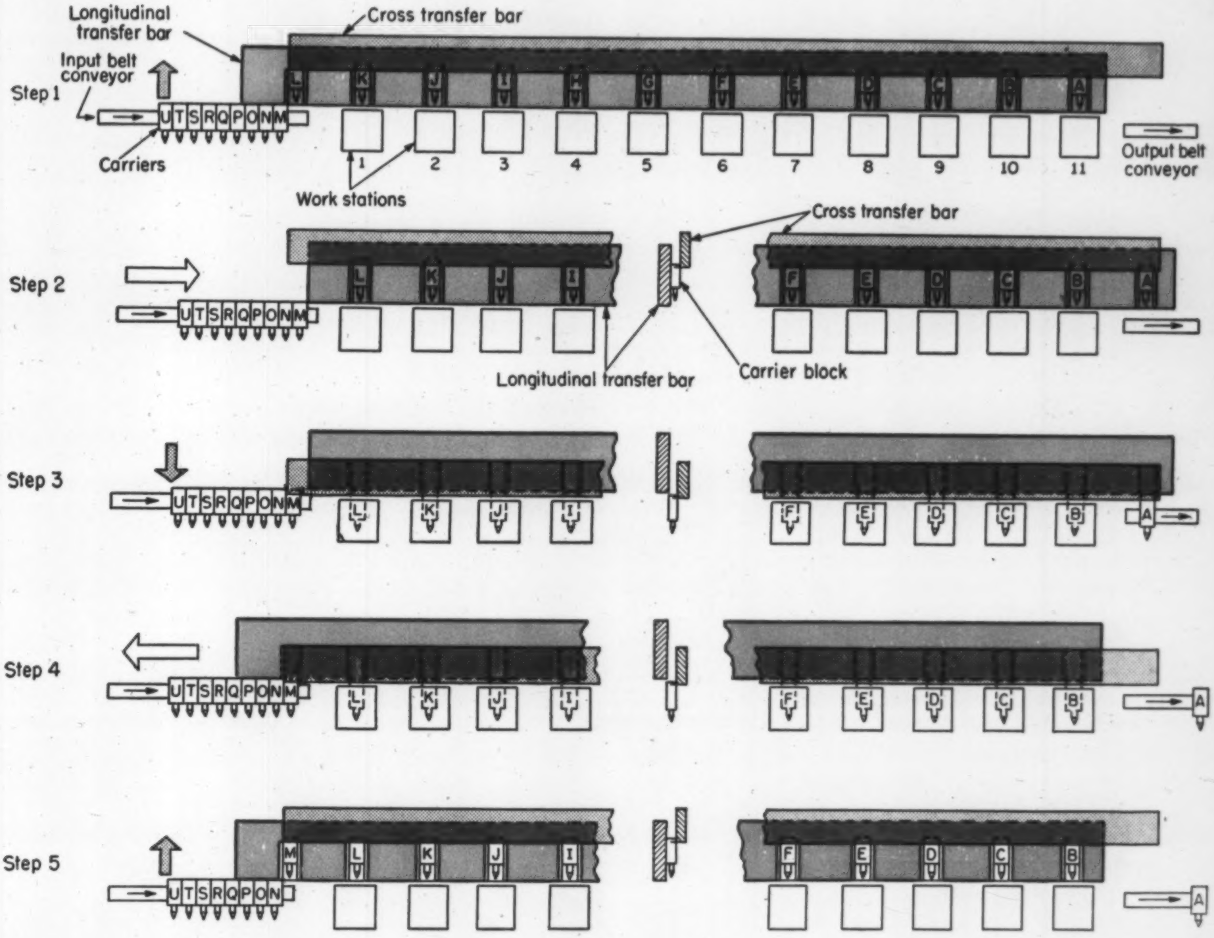

Metal tab
Solder
Germanium blank
0.005 to 0.007 in.
Before Etching
Etched collector
Etched emitter
0.0007 in.
After Etching
Indium alloy
0.002 in.
After Attaching Whiskers

ACCURATELY MACHINED CARRIER BLOCKS made of stainless steel serve as movable fixtures for the germanium blanks. These carriers are fitted with jaws which grip a metal tab soldered to each germanium blank. Belt conveyors feed these carriers into the etch-plate machine which is located at the beginning of the line.

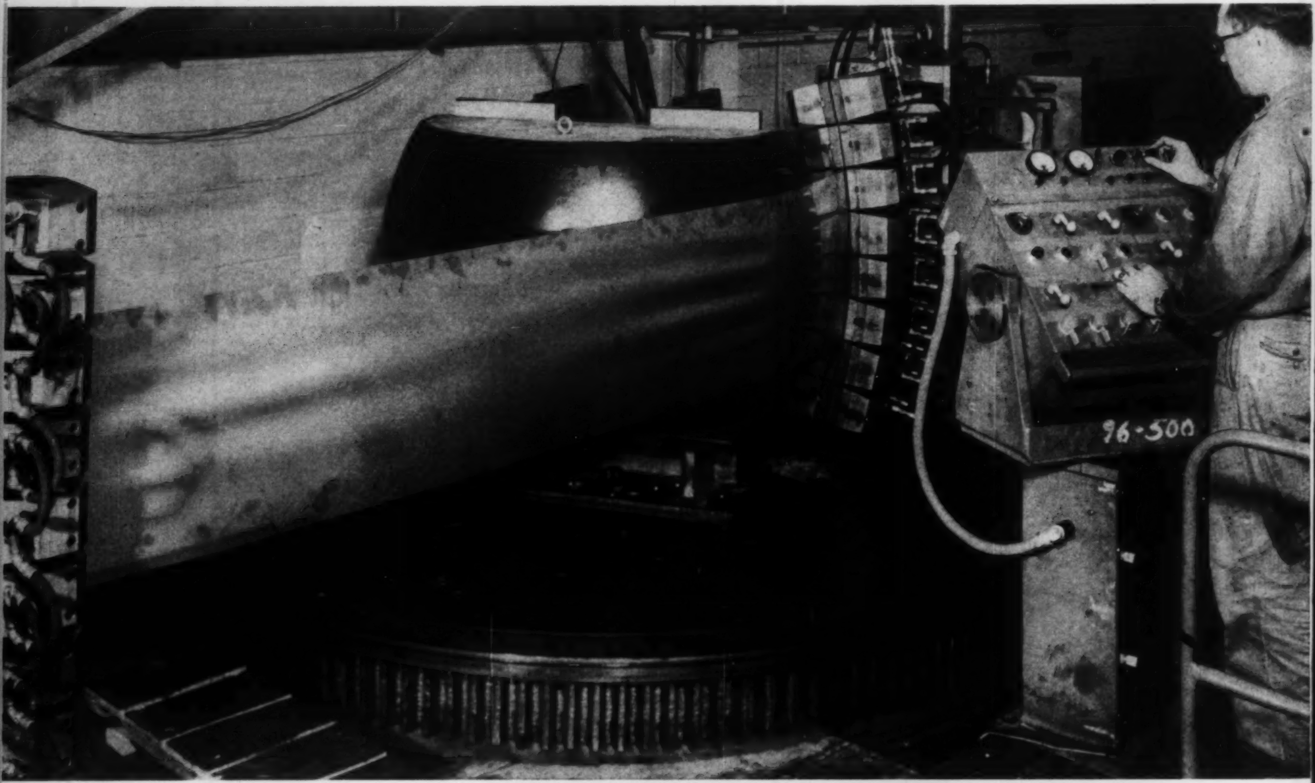
Via Backsliding "Conveyor"

CARRIERS SHUFFLE ON AND OFF the transfer-bar mechanism successively advancing from station to station. The loaded carrier blocks are pulled into pockets on the longitudinal transfer bar by the cross transfer bar. The longitudinal transfer bar advances the carriers a distance of one station; the cross transfer bar pushes the carriers completely off of the longitudinal transfer-bar mechanism and precisely positions them in the workstations. The longitudinal transfer bar, with no carrier blocks on it, backslides a distance of one work station. At the proper time, the cross transfer bar pulls the carriers out of the workstations plus one new carrier from the input belt conveyor. The cycle then repeats.

During each cycle a carrier is deposited on the output conveyor belt and a new carrier is pulled on to the transfer bar mechanism.


Longitudinal transfer bar
Cross transfer bar
Input belt conveyor
Step 1
U T S R Q P O N M
L K J I H G F E D C B A
Carriers
1 2 3 4 5 6 7 8 9 10 11
Work stations
Output belt conveyor
Step 2
Cross transfer bar
Longitudinal transfer bar
Carrier block
Step 3
Step 4
Step 5

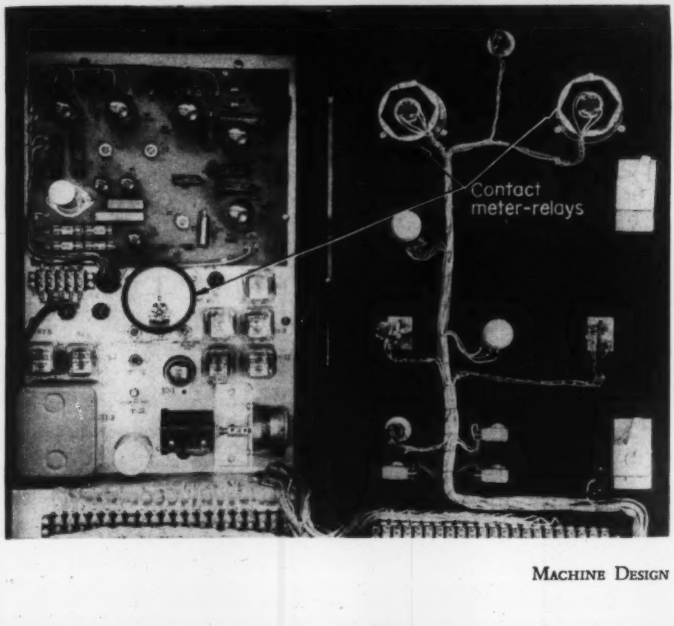
Meter-Relay Control System



ACCURATE STRETCH FORMING of exotic metals is assured with a special electronic control system built by Assembly Products Inc., Chesterland, O. Developed for a Cyril Bath radial forming machine installed in the Convair Astronautical Lab., San Diego, Calif., the unit employs three locking-contact meter-relays to simplify circuit design and cut control costs.

The control system automatically measures the yield point of the metal to be shaped by the machine and also controls the stretching and forming operations of the machine.

In operation, the machine grips the metal between jaws and simultaneously stretches and forms the metal against dies on a revolving table.



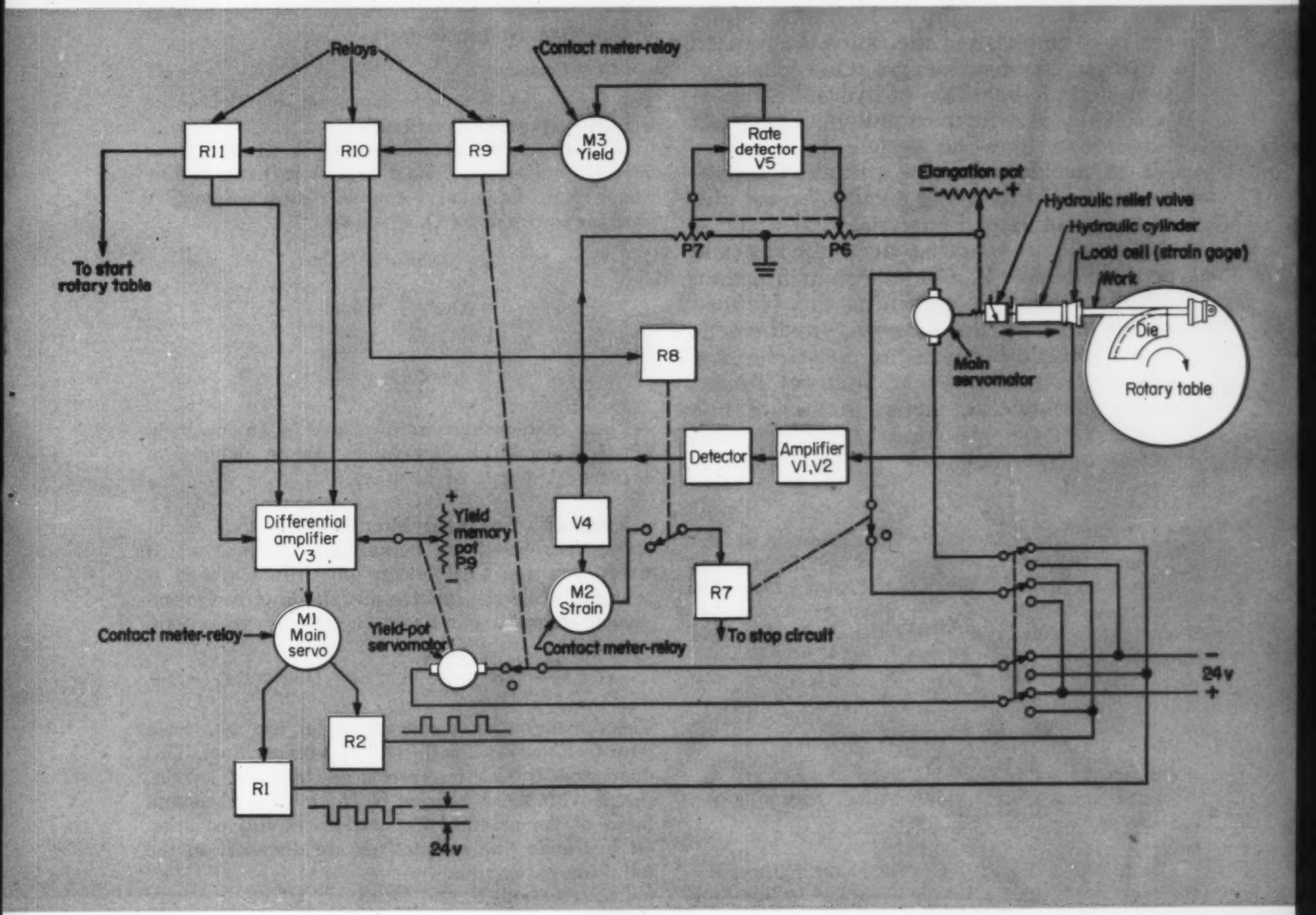
Predetermines Yield Point of Metals

YIELD POINT OF THE METAL is found by measuring tension and elongation before the metal is brought into contact with the forming dies. Tension in the metal is detected by a special Cyril Bath load cell, which acts as a strain gage. The elongation signal comes from a potentiometer link to a servomotor-controlled hydraulic relief valve. This valve controls pressure in the hydraulic cylinder which stretches the metal being formed.

The control circuit uses a zero-center meter-relay (yield meter) to detect when metal elongation increases faster than does tension. At this point the indicating pointer makes contact with the high-limit pointer on the yield meter, M3, and energizes relay R9. This action stops motor-driven potentiometer P9, which has been controlling the increase in applied tension. Potentiometer P9 remembers this yield point during the forming run on the metal in the machine. Tension is maintained either at this point or slightly lower.

Contact meter relay M1 controls the servomotor that maintains proper tension during metal shaping.

Contact meter relay M2, which is known as the strain meter, indicates actual tension applied to the metal during forming and automatically shuts down machine if metal happens to break.



Relays
Contact meter-relay
R11
R10
R9
M3 Yield
Rate detector V5
Elongation pot
− +
Hydraulic relief valve
Hydraulic cylinder
Load cell (strain gage)
Work
P7
P6
To start rotary table
Main servomotor
Die
Rotary table
R8
Detector
Amplifier V1,V2
Differential amplifier V3
+
Yield memory pot P9
−
V4
M2 Strain
R7
To stop circuit
Contact meter-relay
M1 Main servo
Yield-pot servomotor
Contact meter-relay
−
24v
+
R2
R1
24v

An Engineering Approach to HYDRAULIC LINES | No. 1

Fundamentals of Line Flow

By JAROSLAV J. TABOREK
Research and Development Engineer
Phillips Petroleum Co.
Bartlesville, Okla.

Increased demands for more speed, higher power, and less weight in hydraulic equipment have emphasized the rational approach to hydraulic-system design. One phase of system design—selection of hydraulic lines—is receiving particular attention. The effect of hydraulic lines on system performance can't be avoided. So, the attitude, "a half-inch line ought to be big enough," must give way to one of careful analysis.

As an aid in selecting the right size and type of hydraulic line for the right function, MACHINE DESIGN is presenting this planned program of six articles. Covering the theoretical and practical aspects of hydraulic line applications, this program discusses fundamentals of line flow, determination of line size, selection of pipe, hose, and tubing, and selection of connectors.

SELECTION of hydraulic lines depends on the pressure and flow developed in the system, and the ability of the lines to dissipate heat. The first article in this program discusses the fundamental principles and theories involved in line selection.

Basic Equations

All flow characteristics for line elements are determined from several fundamental hydraulic relationships.

Continuity of Flow: Since fluids are matter, the conservation of mass principle is applied to line flow to obtain an equation of continuity which relates the flow velocity to the cross-sectional flow area of a line (see Nomenclature):

$$vA\rho = \text{Constant} \qquad (1)$$

For isothermal flow of noncompressible fluids, the density is considered constant.

If flow velocity v is expressed in terms of flow rate Q, and cross-sectional area A in terms of line diameter d_i, Equation 1 can be rearranged to give working equations for Q, v, and d_i:

$$Q = 2.45 v d_i^2 = 3.12 v a$$

$$v = 0.408 \frac{Q}{d_i^2} = 0.321 \frac{Q}{a}$$

$$d_i = 0.639 \sqrt{\frac{Q}{v}}$$

These relationships are combined in a nomogram, Fig. 1, from which flow values can be obtained to a practical degree of accuracy.

Bernoulli's Equation: Most hydrodynamic calculations are based on Bernoulli's equation, which states that the total energy of a fluid system is constant while the relative magnitude of each component changes. For hydraulic system applications,

$$\frac{P}{\gamma} + \frac{v^2}{2g} + \mathrm{H} + \sum e_t + e_m = \text{Constant} \qquad (2)$$

The dimension most convenient for use with each term in Equation 2 is lb-ft/lb of working fluid. This dimension is also interpreted as feet and is consistent with the dimension of H for static elevation. Some of the practical implications of this equation on hydraulic line calculations are discussed in the following paragraphs.

PRESSURE AND STATIC HEAD: If all other energy

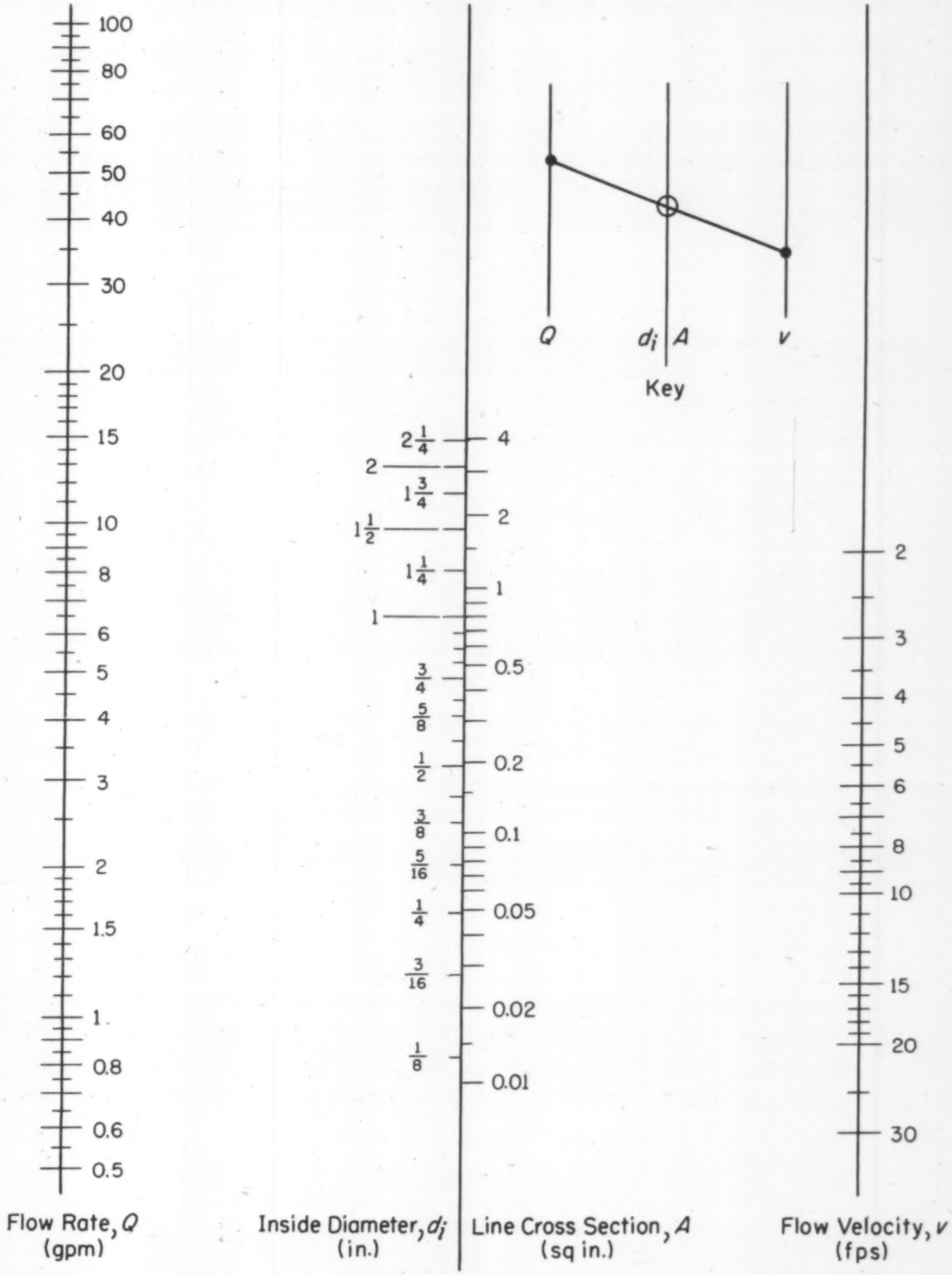


Fig. 1—Nomogram for continuity equation

forms in Equation 2 are assumed constant, the pressure and static head at two different elevations are obtained:

$$\frac{P_1 - P_2}{\gamma} = H_2 - H_1 \qquad (3)$$

Equation 3 can be simplified to give

$$\Delta P_h = 0.433 \Delta H G \qquad (4)$$

Applying Equation 4 to closed circuits, $\Sigma \Delta H = 0$.

Nomenclature

A = Area, ft^2
a = Area, in.^{2}
B = Bulk modulus, psi
C_c = Coefficient of contraction
C_d = Coefficient of discharge
C_r = Coefficient of heat radiation, Btu/hr/deg F/ft^2
C_{ti} = Coefficient of heat transfer for the inside of the tube, Btu/hr/deg F/ft^2
C_{to} = Coefficient of heat transfer for the outside of the tube, Btu/hr/deg F/ft^2
C_v = Coefficient of discharge velocity
c = Heat capacity, Btu/lb/deg F
D = Diameter, ft.
D_i = Inside diameter, ft
d_i = Inside diameter, in.
E = Modulus of elasticity, psi
e_m = Mechanical energy, lb-ft/lb
e_t = Heat energy, lb-ft/lb
f = Coefficient of friction
G = Specific gravity
g = Gravitational constant, ft/sec^2
H = Height, ft
ΔH = Terminal elevation difference, ft
h = Height, in.
K = Flow resistance coefficient
k = Material conductivity, Btu/hr/deg F/ft
L = Length, ft
N = Power, ft-lb/sec, or hp
P = Pressure, psf
p = Pressure, psi
p_e = Mean effective operating pressure, psi
p_s = Pressure surge, psi
Δp Pressure differential, psi
p_h = Pressure differential due to static elevation differential, psi
Q = Flow rate, gpm
Q_e = Mean effective flow rate, gpm
q = Rate of heat absorption, Btu/hr
R = Reynolds number
S = Thickness, ft
s = Thickness, in.
T_{aR} = Air temperature, deg R
T_{wR} = Wall temperature, deg R
ΔT = Temperature difference, deg F
t_c = Critical time, sec
t_v = Time of valve closure, sec
V = Volume, ft^3
v = Velocity, fps
v_p = Velocity of wave propagation, fps
W = Weight, lb
$\gamma = \rho g$ = Specific weight, lb/ft^3
ε = Emissivity
η = Efficiency
$\rho = \gamma/g$ = Density, lb-sec^2/ft^4

Static head is often used in hydraulics as a measure of pressure, and is expressed in terms of feet or inches of the measuring fluid, usually water or mercury. For water, $p = 0.433\,H$, where H = height of water, and for mercury, $p = 0.491\,h$, where h = height of mercury. From these relationships, the static head of water can be expressed as static head of mercury:

$$H(\text{ft water}) = 1.13\,h(\text{in. mercury}) \qquad (5)$$

While heads due to static differences usually do not amount to much in lines of high-pressure hydraulic circuits, they can be of great importance in suction lines, where the permissible pressure drop is limited by the acceptable pump vacuum.

FLOW VELOCITY: The relation between the velocity head and the other energy terms is obtained from the equation

$$P = \frac{v^2\gamma}{2g} + H\gamma \qquad (6)$$

where the terms are in pressure units, and the velocity term is called velocity pressure. From Equation 6, the flow velocity, in terms of pressure and static head, is

$$v = C_v \sqrt{\frac{2g}{\gamma}(P + H\gamma)} \qquad (7)$$

where C_v reflects the effect of the orifice shape on the actual fluid velocity. Approximate values for C_v under various orifice conditions are given in Fig. 2.

High pressures used in hydraulic circuits can cause very high flow velocities. For example, a line break in a 1000-psi circuit would produce a discharge velocity of 320 fps if $C_v = 0.8$.

Discharge velocity is also used to determine the discharge volume from the equation

$$Q = C_c v A = C_d A \sqrt{\frac{2g}{\gamma}(P + H\gamma)} \qquad (8)$$

where C_c = coefficient of contraction, which accounts for the effective contraction of the stream as compared to the actual area, and $C_d = C_v C_c$ = discharge coefficient. The most important application of orifice discharge calculations is for flow measurements. If the pressure drop through a line orifice is determined, the velocity and flow volume can be calculated by using flow coefficients. Flow coefficients are functions of Reynolds number, diameter ratios, and edge shapes, and are difficult to obtain.

Pressure Factors

Two basic factors must be determined before a line is selected: 1. How much pressure will be lost through line inefficiency? 2. How much pressure, over and above normal operating pressure, is encountered in the line?

Pressure Drop: The total pressure supplied to a line is made up of the usable pressure or output and the pressure lost through transmission of the fluid. Hence, the pressure lost is a measure of the line efficiency and the loss should be kept as small as possible.

Any change in the hydraulic energy form, such as that encountered when fluid flows through cross sections which vary, is followed by disturbances in the velocity distribution and eddy motion. The consequent loss of energy results in pressure drops. Typical examples of hydraulic elements which initiate pressure drops are sudden enlargements, sudden contractions, bends, fittings, and valves. The change in pressure encountered in each of these elements is expressed in terms of the velocity pressure:

$$\Delta p = K \frac{v^2 \gamma}{2g144} \tag{9}$$

where K is a function of geometric and hydraulic conditions. The value of K can be calculated in few simplified cases, but for all practical applications, values must be found experimentally.

SUDDEN ENLARGEMENTS: The pressure loss in a sudden enlargement, Fig. 3, is due to the poor efficiency with which the velocity in a small line is converted into pressure in a larger line. The equation for the pressure lost during the conversion is obtained by applying the Bernoulli equation to each side of the enlargement:

$$\Delta p = \frac{(v_1 - v_2)^2 \gamma}{2g144} \tag{10}$$

When the respective flow areas are substituted in Equation 10,

$$\Delta p = \left(1 - \frac{A_1}{A_2}\right)^2 \frac{v_1^2 \gamma}{2g144} \tag{11}$$

and the coefficient $K = [1-(D_1^2/D_2^2)]^2$. If the final velocity in the enlarged section is negligible, which is the case when the flow is discharged into reservoirs, the pressure loss equals the full velocity head with $K = 1$.

For gradual cone-shaped enlargements, K is found experimentally and reaches an approximate value of 0.2 at a cone angle of approximately 10 deg.

SUDDEN CONTRACTIONS: Values of K for sudden contractions, Fig. 4, cannot be obtained by simple analysis. However, when $D_2^2/D_1^2 < 0.72$, an approximate value of $K = 0.4\ [1.25 - (D_2^2/D_1^2)]$ can be used. Similarly, when $D_2^2/D_1^2 > 0.72$, $K = 0.75\ [1-(D_2^2/D_1^2)]$. When a fluid flows from a line of extremely large area to one of small area, as in the case of flow from a reservoir, K becomes a function of the entrance edge-configuration, since D_2/D_1 becomes zero. For sharp, 90-deg edges, $K = 0.5$; for beveled edges, $K = 0.3$; for rounded edges, $K = 0.05$; and for projected line entrances, $K = 0.8$.

BENDS: As fluid passes through a bend in the line, frictional forces on the line walls combine with

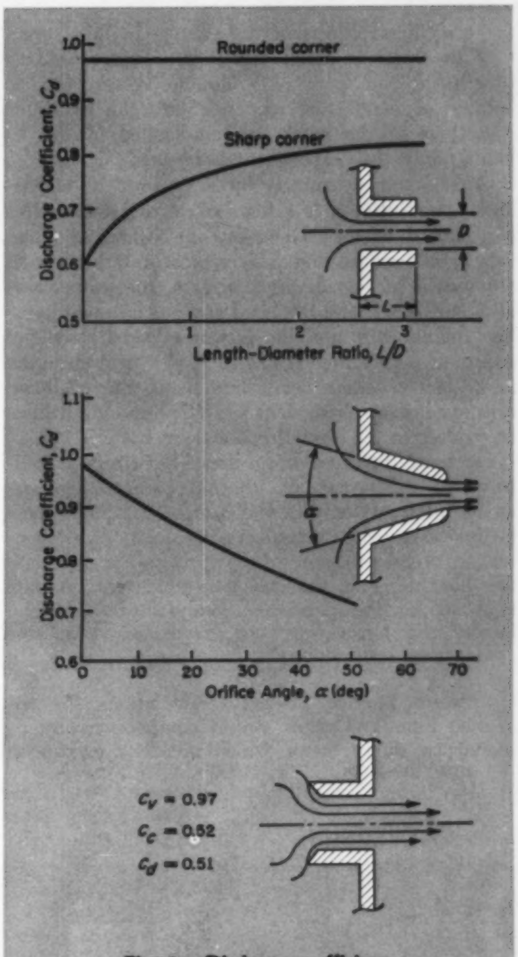
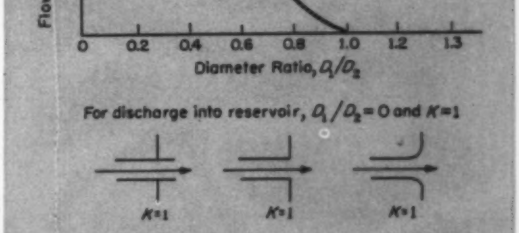


Fig. 2 — Discharge coefficients for typical orifices



For discharge into reservoir, $D_1/D_2 = 0$ and $K=1$

Fig. 3—Flow resistance of sudden enlargements

the centrifugal effects of the change in flow direction to create a secondary flow. This secondary flow takes the form of a double vortex, Fig. 5, within the bend cross section. Since the hydraulic conditions in the bend are complicated, K can be found only by experimental means.

Correlations attempted by a number of experiments show that K is a function of the bend radius and line diameter. However, the values obtained vary considerably, and only representative averages are shown in Fig. 5. Furthermore, the proportionality between K and the bend angle is not a straight-line relationship, and the minimum bend resistance occurs at approximately $r/d = 4$. To determine the total flow resistance of a line bend, the frictional resistance of an equivalent straight-line length must be added to K, the directional resistance.

FITTINGS: Pressure drop through fittings is sensitive to differences in internal passage arrangements, edge angles, and wall roughness. Since these factors vary with manufacturing methods, a generalized representation of flow resistance values is not possible, and the designer must rely on data supplied by the particular manufacturer. Similar factors also affect resistance values for valves and other flow restrictions.

Pressure Surges: Strength calculations for hydraulic lines and other circuit components usually include a safety factor which accounts for uncertainties in hydraulic conditions. One of these uncertainties exists because the highest pressure which occurs in a hydraulic system is not the relief-valve pressure, but is an extremely short-lived pressure peak created when a hydraulic line-shock is added to the normal operating pressure.

If a valve in the line is closed, the fluid flow stops suddenly, and a pressure wave is generated by the unconsumed kinetic energy in the fluid throughout the line. This pressure wave travels through the downstream line, at the speed of sound for the fluid, until the wave is reflected back to the point of origin. If the system has branches, the wave is reflected by each branch separately. This phenomenon is repeated, with shock waves overlapping each other, until the original kinetic energy is absorbed by friction. These shock waves are often referred to as water hammer because of the noise and vibration that usually accompanies the wave.

Shock waves are generated when the deceleration of the fluid column, or the time of valve closure, t_v, is shorter than the time required for the wave to travel downstream and return to the valve. This time increment is called the critical time, t_c, and is

$$t_c = \frac{2L}{v_p} \geqq t_v \qquad (12)$$

The velocity of sound or of wave propagation, v_p, in the hydraulic fluid is a function of the fluid compressibility and the elasticity of the line material, and is given by the equation:

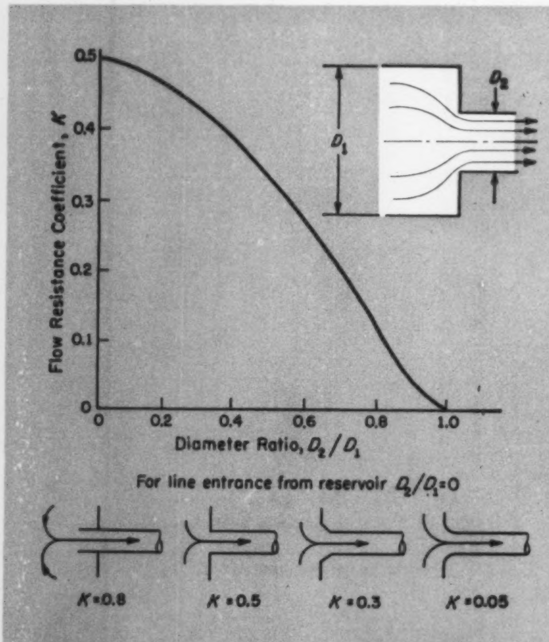


Fig. 4—Flow resistance of sudden contractions

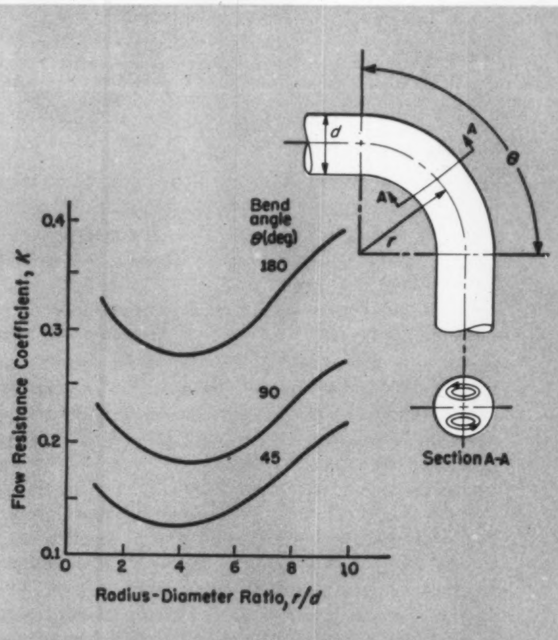


Fig. 5—Flow resistance in pipe bends

$$v_p = \frac{12\sqrt{\dfrac{gB}{\gamma}}}{\sqrt{1 + \dfrac{B d_i}{E s}}} \qquad (13)$$

Since the differences in γ and B for the usual hydraulic fluids (water to light oils) are small, and since the ratio d_i/s has a relatively constant value of 10 for most circuit conditions, an average velocity of sound, $v_p = 4500$ fps, can be used with moderate accuracy for all calculations.

The pressure surge due to shock waves is

$$p_s = \frac{\gamma}{144 g} v_p v \qquad (14)$$

where v is the original flow velocity in the line. Substituting $v_p = 4500$ and values of γ (ranging from 55 for oils to 62.4 for water) into Equation 14, an approximate pressure surge value, $p_s = 60v$, is obtained. Hence, the pressure shock is proportional to the initial flow velocity only. Since flow velocities of 20 fps are not unusual in hydraulic circuits, surge pressures can reach a magnitude of 1200 psi. The actual maximum pressure for which circuit components must be designed is obtained by adding the normal operating pressure to this shock pressure. If rubber hose is used in a portion of the line system, some of the pressure wave will be absorbed, and the shock wave will be decreased considerably.

The above equations were developed under the assumption that t_v was less than t_c. If the valve closure time is longer than the critical time, a pressure wave of lesser magnitude will be developed, since only a portion of the kinetic energy is reflected. When t_v is greater than t_c, the surge pressure is

$$p_s = \frac{\gamma v_p v}{144 g \left(\dfrac{v_p t_v}{L} - 1 \right)} \qquad (15)$$

If $v_p = 4500$ and $\gamma = 55$ are substituted in Equation 15, an approximate expression for the surge pressure is

$$p_s = \frac{60\, v}{\left(\dfrac{4500\, t_v}{L} - 1 \right)} \qquad (16)$$

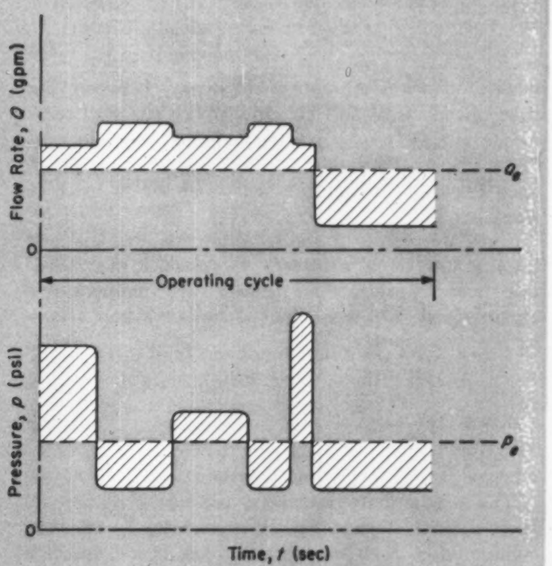


Fig. 6—Mean effective flow rate and mean effective pressure. Integral average determined from the time diagram of actual values

Power Requirements

The power required to maintain certain conditions of pressure, velocity, and static head in the circuit is calculated directly from Equation 2. If Equation 2 is multiplied by the time rate of flow, $W/t = Q\gamma$, and if the expression is put in terms of common units, the pump-shaft power input is

$$N = \frac{Q}{1714\eta} \left(p + \frac{v^2 \gamma}{2g144} + \frac{H\gamma}{144} \right) \qquad (17)$$

This is a general pump equation and accounts for the effect of static height and velocity head as well as the actual pressure.

In hydraulic circuits, the pressure requirements are usually so predominant over the other two energy forms that the static height and velocity head terms are usually neglected. However, if the pressure term is interpreted as the pressure required at the machine which is performing work, the pump must deliver a pressure which includes all the pressure losses in the delivery system, $\Sigma\Delta p$, and the over-all power equation is

$$N = \frac{Q}{1714\,\eta} (\Sigma p + \Sigma\Delta p) \qquad (18)$$

The term $\Sigma\Delta p$ is interpreted as either a summation of the energy forms inside the parentheses of Equation 17, or, if the insignificant energy forms are neglected, as the plain static pressure delivered to the working mechanism of the system.

Thermal Considerations

Flow rate of hydraulic fluid in lines is a function of the internal fluid and wall friction characteristics.

Temperature Rise: The energy required to overcome this frictional work is drawn from the pressure energy content of the fluid, and shows up as a pressure drop, Δp. Pressure loss due to friction is an irreversible process, and the loss ultimately takes the form of heat, which raises the temperature of the fluid. The mechanical energy lost as a result of the pressure drop is

$$N = \frac{Q\Delta p}{1714} \tag{19}$$

If the pressure drop is concentrated in one spot so that no appreciable heat dissipation can take place, the theoretical temperature rise produced is determined from the heat storage equation,

$$q = 60(0.134)Q\gamma c\Delta T \tag{20}$$

If the conversion of 1 hp = 2545 Btu/hr is introduced in Equation 19, and Equations 19 and 20 are equated, the temperature rise caused by the pressure-drop resistance is

$$\Delta T = \frac{\Delta p}{340cG} \tag{21}$$

From Equation 19 and an interpretation of the pressure drop under actual circuit working conditions, the heat-generating pressure and energy loss are made up of two factors:

1. The summation of all pressure losses, $\Sigma\Delta p$, which are a function of the flow velocity. Included in this group are pressure losses which occur in restrictions, bends, and fittings, and the losses due to internal pipe friction (to be discussed in article two of this program). The flow velocity should be determined from the mean flow rate, Fig. 6, which is the integral average obtained through a typical working cycle or extended period of time. Using the mean flow rate as a basis for determining the flow velocity is especially important when the pump speed changes considerably with time.
2. The pressure loss, $p_e(1 - \eta)$, which develops because of pump inefficiency. This loss is function of a mean effective operating pressure, which is an integral average taken for a typical working cycle, Fig. 6. The effective operating pressure is a constant fictitious pressure which produces an energy loss equal to the loss actually caused by the changing working pressure.

From the preceding definitions of the pressure losses discussed, Equation 20 can be transformed into thermal units:

$$q = 1.49Q_e[\Sigma\Delta p + p_e(1 - \eta)] \tag{22}$$

This equation represents the amount of heat energy constantly produced in the system. Hence, to keep the temperature of the fluid at a certain level, the same amount of heat must be steadily dissipated in the hydraulic system.

HEAT BALANCE: When a cold hydraulic system is started, the fluid is highly viscous and develops a high flow resistance and pressure drop. This resistance creates vehement heat generation, which is higher than the heat-dissipation potential of the system. Hence, temperature of the fluid starts to rise, causing the fluid viscosity and the pressure drop to decrease.

Simultaneously, the heat transferred to the surrounding medium increases, because of the higher temperature difference between the surface and air. This process is repeated until a heat flow balance is reached. To obtain a correct circuit design, thermal equilibrium of the system must be reached at temperatures and fluid viscosities which will not impair proper functioning of the circuit. If natural heat dissipation from the circuit surfaces is not sufficient, a heat exchanger can be included in the circuit.

HEAT DISSIPATION: Hydraulic systems are classified in two types for the purposes of considering the mechanics of the heat dissipation. For stationary units, the heat transfer occurs by natural convection and by radiation. When an air stream is directed against hot circuit elements, forced convection takes place. Although the conditions pertinent to heat transfer calculations are difficult to ascertain, a knowledge of these principles can help in properly estimating design qualities and their expected effect.

The total heat transferred is

$$q = A\Delta T\left(\frac{1}{\frac{1}{C_{ti}} + \frac{1}{C_{to}} + \frac{S}{k}}\right) \tag{23}$$

where the term in parentheses represents the overall heat-transfer coefficient and ΔT = temperature difference between the tube fluid and outside air.

The coefficient for the inside of the tube, C_{ti}, is

$$C_{ti} = 0.023\frac{k}{D_i}R^{0.8}\left(\frac{c\mu}{k}\right)^{0.4} \tag{24}$$

where, for industrial hydraulic oils, $k = 0.08$, $c = 0.5$, and $\mu = 25$.

The coefficient for the outside of the tube is approximately

$$C_{to} = 0.23\sqrt[4]{\Delta T} \tag{25}$$

where ΔT = temperature difference between the tube outside wall and air, and where the wall temperature closely approximates the oil temperature. Only the smallest value of the temperature difference between the outside wall and air is used in Equation 25.

Since the value of the outside-tube coefficient is usually low, it is necessary to consider the radiative heat transfer, even though low temperatures are involved. The coefficient of radiative heat transfer is approximately

$$C_r = 0.173\,\varepsilon\,\frac{\left(\frac{T_{wR}}{100}\right)^4 - \left(\frac{T_{ae}}{100}\right)^4}{\Delta T} \tag{26}$$

where $\varepsilon = 0.65$ for hydraulic systems.

The conductivity resistance used in Equation 23 is calculated from the wall thickness, S, and the conductivity, k. The values which result indicate that the wall resistance for steel is negligible when compared to the high resistances of the outside heat-transfer.

Since heat transfer inside of the tube and conductivity of the walls represent small resistances compared to the outside heat transfer, they are neglected and Equations 23 and 26 are combined to give

$$q = (C_{to} + C_r)A\Delta T \qquad (27)$$

Although this equation was developed from theoretical considerations, it agrees with correlations based on average industrial circuits and with empirical heat-dissipation equations. Substitution of the heat generated, the radiative heat-transfer coefficient, and the outside-tube coefficient into Equation 27 gives the area of heat-dissipating surface required. Although wide variations in hydraulic conditions limit the value of this calculation, several general conclusions can be drawn from the results:

1. High flow velocity should be maintained inside the tubes to assure good heat transfer to the outside surface of the tube. The higher the surface temperature, the greater the quantity of heat transferred per foot of area.
2. Rubber hoses have high resistance to heat conduction and therefore, low surface temperatures. Hence, rubber hose should be used only for short connections where flexibility is required and when heat dissipation is not critical.
3. Heat dissipation is frequently impaired by improper design of hydraulic reservoirs. Baffles, properly placed with respect to inlet and outlet locations, should force the fluid to circulate around the circumference of the walls, which increases the heat-transfer rate. To carry the heat away, outside air should have free access to the outside area of the reservoir.
4. In average industrial applications, 12,000 Btu/hr is the maximum heat load which can be dissipated by natural convection. Above this figure, some method of complementing the heat transfer must be used, and eventually a heat exchanger must be included in the circuit.

The second article in this planned program on hydraulic lines will be titled, "Determining Line Size," and will discuss the effects of line size on the over-all system performance.

Tips and Techniques

Winding Thin Materials

A set of simplified equations can be used in the design of equipment which has spools or rolls for winging long, thin materials, such as motion picture film or recording tape. To find number of turns n of material on the spool when the total length and thickness of the material and the core diameter are known, use the equation,

$$n = \frac{-(c+t) \pm [(c+t)^2 + 4ts/\pi]^{1/2}}{2t}$$

where c = core diameter, t = material thickness, and s = total length of material, all expressed in the same units.

To find the total length of material wound on a spool of a given size with a given number of turns, use

$$s = n\pi[c + (n+1)t]$$

To find the final or largest diameter, D, of a roll of material on a certain core, use

$$D = c + 2nt$$

—Walter G. Mayer, *design draftsman, Flight Research Inc., Richmond, Va.*

Experimental Soldering

Electric gun-type soldering irons have tips which are too large for most close work involved in experimental assembly of electronic equipment. To modify the iron for this type of service, cut off the large tip, cut back one of the two protruding copper conductors approximately 3/8 in., and braze the two conductors back together. The tip of the iron is now the size of one of the conductors and is small enough to permit its use on even the closest connectors.—Herbert A. Krivka, *Vitro Laboratories, Silver Spring, Md.*

Sheave Center Distance

A simplified formula can be used to determine the approximate center distance between two sheaves in a V-belt drive when the belt length and sheave sizes are known. If R = radius of large sheave, r = radius of small sheave, and L = belt length, all expressed in like units, distance between centers of sheaves is, approximately:

$$x = \sqrt{\left(\frac{d}{2} + \sqrt{c}\right)\left(\frac{d}{2} - \sqrt{c}\right)}$$

where $d = L - \pi(R + r)$ and $\sqrt{c} = (R - r)$. This approximation gives values which are accurate to 0.002 per cent when $[L/(R - r)] > 20$, and 0.2 per cent when $[L/(R - r)] > 10$. The error increases rapidly for $[L(R - r)] < 10$, and the equation is not recommended for use in this range. —J. Ross Baker, *development engineer, Cincinnati Milling Machine Co., Cincinnati, Ohio.*

Do you have a helpful tip or technique for our other readers? You'll receive ten dollars or more for each published contribution. Send a short description plus drawings, tables, or photos to: Tips and Techniques Editor, Machine Design, Penton Bldg., Cleveland 13, O.

low-cost methods for adjusting

Low-cost adjustable-speed drive for bearing tester. Armature voltage to the $1/2$-hp motor can be changed with the variable transformer at left. Ac power rectifiers are in the control box at right. Stepped changes in speed can be obtained by switching a tapped transformer located in the control box

Table 1—Comparison of Manual Speed-Adjustment Methods for Standard DC Compound Motors

	Speed Regulation (per cent)	Speed-Adjustment Range	Efficiency of Adjustment Method	Application Factors
Line Rheostat	Dependent on load	Dependent on load	Low	Used on universal ac-dc and dc series motors, normally up to ½ hp. Above this size, heat dissipation may become a problem. Only one rectifier is required. Applications include fans, pumps, and other loads in which torque decreases with speed.
Armature Rheostat	50*	2 to 1†	Low	System provides a constant-torque output used in applications up to base speed, i.e., grinders, projectors, etc. Used normally up to ½ hp. Above this horsepower, size and heat dissipation may become a problem. Two full-wave rectifiers are needed.
Field Rheostat	Little effect on regulation	1.5 to 1	High	Used for operating motors above base speed at constant hp. Rheostat almost always used in field-weakening range. Limited by stability factor of motor. Motor will run away if field voltage is reduced to zero. Two full-wave rectifiers needed.
Armature Variable Transformer	30*	10 to 1§	Very High	Well suited for applications requiring only moderately accurate, low-cost drive systems. Must be operated on ac and is somewhat heavier than a rheostat. Requires two full-wave rectifiers. Typical applications include office machines, machine tools, health machines, etc.

*Regulation includes 25 per cent inherent in a standard compound dc motor.

†Speed is actually adjustable from 0 to base speed. However, speed range is based on a normal useable range to keep control size within reason.

§Based on transformer efficiency above 80 per cent. Actually speed is adjustable from zero to base speed.

speed of fhp motors

By **S. E. TOMKINSON** and **N. L. MORGAN**
Design Engineer Application Engineer
Specialty Motor Dept., General Electric Co., Ft. Wayne, Ind.

IN MANY applications, highly accurate control of motor speed is required. Elegant methods of speed detection are needed along with elaborate signal-amplification or feedback equipment, which means expensive electrical and electronic control apparatus are a must. However, on applications where moderate regulation can be tolerated and amplification or feedback is not necessary, simple methods of speed control offer cost advantages.

Methods of Adjusting Speed

Essentially there are only two ways of changing speed of a low-horsepower dc or universal motor: 1. Adjust motor armature voltage. 2. Adjust motor field voltage. Any speed below base speed at rated voltage is obtained by decreasing the voltage across the armature, Fig. 1*a*. As armature voltage is changed, speed changes, but torque remains constant over the full speed range up to base. Motor speed is almost directly proportional to armature voltage.

Motor speed can also be lowered by decreasing line voltage, Fig. 1*b*. Since this method reduces motor torque and efficiency, as well as speed, it is usually limited to simple general-purpose applications. In special cases, motor speed can be cut by increasing the field voltage, which produces a constant-horsepower relationship. But this procedure is generally used only on intermittent-duty applications because the motor usually overheats when field voltage is higher than normal.

Motor speeds of higher than base speed are normally obtained by controlled reduction of the field voltage, Fig. 1c. By this technique, speed is increased, at constant horsepower, through a normal range with standard compound motors to about 150 per cent of base speed. In Fig. 2 is a generalized pic-

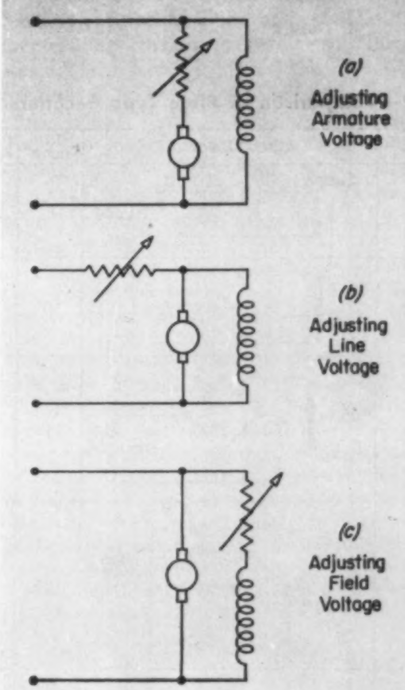
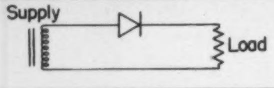
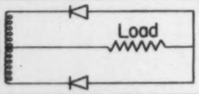
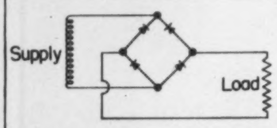
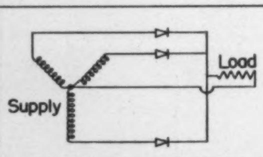
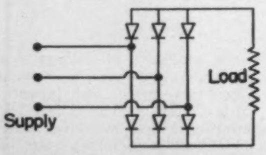


Fig. 1—Three methods of manually adjusting dc motor speed. Increasing resistance in circuit *a* decreases speed and power input; full-load torque can be held constant although available torque decreases. Increasing resistance in circuit *b* decreases motor torque, speed, and power input. Increasing resistance in circuit *c* increases speed, decreases torque,

Rheostats provide adjustable-speed control for a commutator turning machine. Motor voltage input is rectified ac power. Armature-voltage control is used in both the 1/3-hp feed motor (lower left) and in a ¾-hp motor located at the base of the machine

Table 2—Comparison of Plate Type Rectifiers

Type of Circuit	Circuit Diagram	Form Factor*	Voltage Factor†
Single-Phase, Half-Wave		1.57	2.22
Single-Phase, Center-Tap, Full-Wave		1.11	2.22
Single-Phase Bridge, Full-Wave		1.11	1.11
Three-Phase, Half-Wave Wye		1.02	1.478
Three-Phase Bridge, Full-Wave		1.001	0.74

*Form factor is the ratio of rms dc pulsating current to dc average current. †Voltage factor is the ratio of dc pulsating voltage to dc average voltage.

ture of speed-torque relationships for both armature and field control. Obviously, motor speed can be controlled over wider ranges by using both armature and field control. A comparison of various methods of manual speed control for a standard compound motor are given in Table 1.

Speed-Control Hardware

The simplest dc-motor speed control requires only two components—a rheostat to adjust voltage input and a rectifier to convert ac to dc. The rheostat can vary line voltage, field voltage, armature voltage, or a combination of these. The line-voltage rheostat is widely used to control universal series-type motors, while the armature rheostat is more commonly applied to dc shunt or compound motors because of their constant-torque characteristics. The field rheostat is very common in all types of speed control for operation above base speed, except for universal series motors.

Variable Transformers: Where increased control and stability, and less regulation, are desired, a variable or adjustable-voltage transformer in place of a rheostat is well worth the slight additional cost. Of course, the transformer must be connected in the circuit ahead of the rectifier. Since the adjustable-voltage transformer has a low *IR* drop in its windings, it provides good voltage stability, increased system efficiency, greater speed range, generally smaller size, and less heating than a comparable rheostat.

Variable transformers are rated on maximum current over a given voltage range. They can be connected to give an ac output higher than line voltage, a feature that can compensate for the inherent rectifier voltage drop.

Rectifiers: Ratings for rectifiers are based on ac rms voltages, current density in plates, and ambient temperatures as specified by rectifier manufacturers, for a given expected life. The life of metallic industrial rectifiers can be as high as 60,000 to 80,000 hours. The current can be increased over rated, at a decrease in life, or by using external cooling means.

Metallic rectifiers are generally purchased as a "complete circuit," i.e., a full-wave bridge, half-wave rectifier circuit, etc. They are available in silicon, selenium, copper-oxide, or germanium construction. Selenium is probably the most popular type, offering advantages of available actual life data, high ambient temperature operation capabilities, and not being as susceptible to transient failures as other types. The new silicon rectifier is beginning to be accepted more widely because of its smaller size, higher efficiencies and, in some cases, lower cost.

Rheostats: Two essential facts are required to choose a rheostat—the required voltage change and the currents involved. With armature-voltage con-

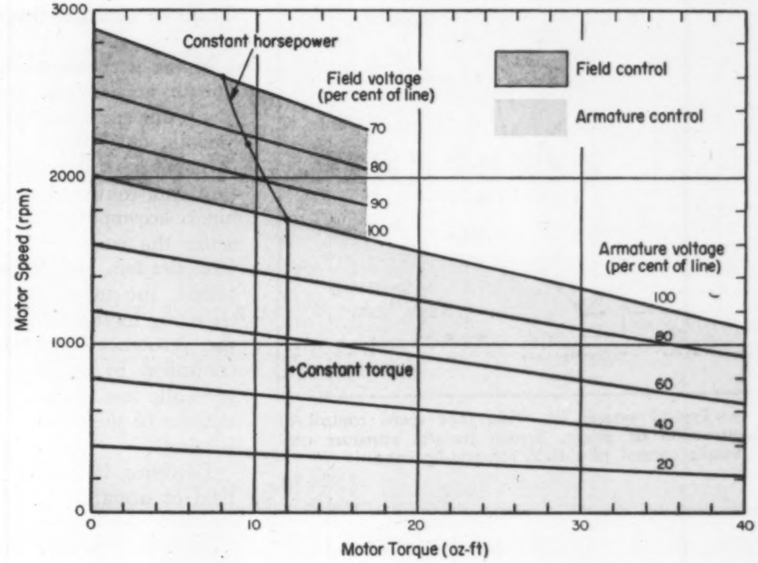


Fig. 2—Speed versus torque curves for armature and field control of a $\frac{1}{4}$-hp, 1725-rpm dc compound motor

trol, field voltage fixed, and torque constant, the current will remain relatively constant, and speed will decrease approximately in proportion to armature-voltage decrease within a 2 to 1 speed range. If line current only is known on a standard dc shunt or compound motor, the armature current can be approximated by assuming it is about 90 per cent of line current.

With field control, iron saturation effects prevent accurate simple calculation of speed increase with decreasing field voltage. However, for a start, the rough approximation that speed is inversely proportional to field current can be used, and the preliminary rheostat chosen with the assumption that it supplies a fixed-resistance field load. Caution should be exercised so that field-weakening speed does not exceed 150 per cent of base speed on standard motors; choose a lower standard rheostat resistance than that calculated.

When torque and speed both vary, the easiest way to determine rheostat size if little motor data are known, is the trial-and-error method. Approximations can be used to find the general resistance area. With fixed field voltage, torque is about proportional to armature current, and since speed is roughly proportional to armature voltage, the approximate maximum resistance to give the required minimum speed can be determined.

Design Application Factors

Rectifier circuit configuration, Table 2, influences the choice of motor ratings because the rectifier does not transform ac into perfectly smooth dc. Since motor heating is affected by rms (root-mean-square) current while useful output is determined by average current, some motor derating is generally necessary if filters are not used to handle the additional heating current. The ratio of effective or rms dc pulsating current to average dc current is known as the form factor.

Motor heating is a result of resistance losses (I^2R) plus other smaller losses, including magnetic and iron. Rectifier power increases the resistance loss and heating by the form factor. Some additional heating above that of resistance can be expected because of small increases in magnetic and iron losses when rectifier power is used.

> EXAMPLE: Assume that a $\frac{1}{3}$-hp load is to be driven by a dc motor operated on half-wave rectified dc which, as Table 2 shows, has a form factor of 1.57. The heating index of the motor equals load horsepower times the form factor, or $0.33(1.57) = 0.552$ hp. Therefore, with this power supply, at least a $\frac{1}{2}$-hp motor of the same voltage and speed rating would have to be used for continuous operation at $\frac{1}{3}$ hp to stay within the heating limits. However, using a full-wave rectifer with a form factor of 1.11, a standard open $\frac{1}{3}$-hp motor with a service factor of 1.15 could be used. In other words, this motor is designed to operate continuously at 115 per cent of rated horsepower anyway. Obviously, full-wave rectification is much better from a heating standpoint which, in turn, affects motor size.

It is important to realize that iron losses will increase heating somewhat above the theoretical form-factor calculations. In standard motors at least a 10 per cent increase in horsepower should be allowed for this.

Rectifiers not only cause an increase in effective motor-heating current, but at the same time they generally reduce average voltage. The ratio of ac rms voltage to average dc voltage, or voltage factor, when multiplied by the required dc average voltage, gives the necessary ac impressed voltage across the rectifier input. The voltage factor values given in Table

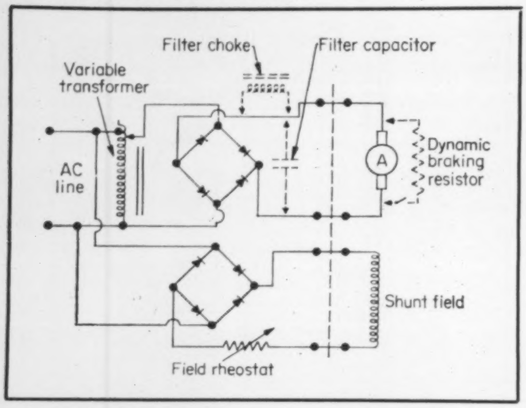


Fig. 3—Typical system for wide-range speed control of a shunt-wound dc motor. System features armature constant-torque control plus field constant-hp control

1 are theoretical resistance load values and do not take into account losses in the rectifier. These losses vary and depend on the physical size of the plates and the number of plates used. Most rectifier suppliers give values for determining their specific losses. In general, they are small, amounting to only a few volts.

As an example of the use of the voltage factor, assume that a single-phase, half-wave rectifier with a theoretical voltage factor of 2.22 is used to supply a 115-volt dc motor. The ac voltage input would then have to be 115(2.22) or 254 volts, neglecting losses. In this example, it's easy to see why full-wave rectification on single phase is so popular. The motor need not be derated drastically, and the input voltage is held within reason.

On applications where speed is adjusted by armature control, the field current should be rectified separately. Because of the high inductance (10 to 20 henries) in the field of shunt and compound dc motors, power-supply ripple increases the form factor much above the theoretical value. Generally, this increased heating in the field does not appreciably affect motor operation. However, if this increased rms current is present in the armature, total motor heating can increase over safe limits. Also, transient voltage caused by commutation across the high inductance of the field in combined field-and-armature rectification generally causes reduction in brush and insulation life.

Filtering: In systems where the motor is worked near its heating limit, filtering can be used to good advantage. Filtering also helps improve motor life and especially brush life. Both capacitor and inductor filtering have been used successfully, Fig. 3. A capacitor in the neighborhood of 200 to 300 microfarads can be connected across the armature to reduce ripple and improve form factor; however, regulation may suffer. A choke in series with the armature line also reduces objectional ripple at the expense of choke *IR* drop in the armature circuit. Generally, field circuits need no further filtering if full-wave rectification is used.

Motor Acceleration and Braking: Very often the smooth acceleration and braking of the dc motor is a prime consideration for its use in an application. Smooth, quick deceleration can be accomplished by dynamic braking, while series resistors in the armature can control acceleration rate. Dynamic braking is accomplished by connecting a low resistance across the armature as the armature is disconnected from the line, Fig. 3. Since the field voltage is maintained, the motor, in effect, becomes a generator changing inertia energy into electrical energy across the resistance load. Consequently, deceleration is controlled by the size of the resistance, which is generally not smaller than about 1/3 to 1/4 the resistance of the armature to prevent undue armature heating.

Reversing is accomplished by reversing either the field or armature polarity. Very rapid reversing or stopping requirements generally use plugging. This consists of reversing the field or armature polarity while the motor is running. Caution must be used with this method because of the possibility of high motor heating.

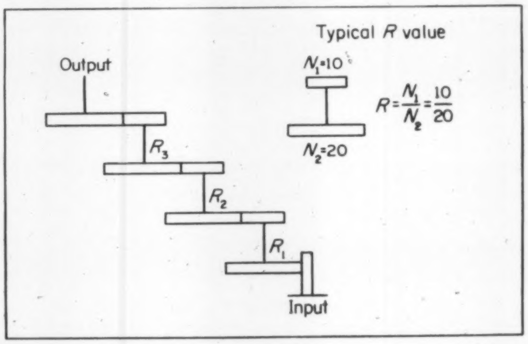
Tips and Techniques

Backlash Calculations

Here is a simplified method for rapid calculation of total gear-train backlash, B_T, when the number of teeth on each gear, N, and the allowable backlash per mesh, B, are known. If $R = N_1/N_2$ = gear ratio on each shaft, the total backlash is

$$B_T = B(R_1R_2R_3 + R_2R_3 + R_3 + 1)$$

where B is the permissible backlash per mesh obtained from standards for a specific class and type of gearing (typical Standard is ASA B6.11-1956).



This equation can be extended for any number of meshing gears in the gear train.—B. J. Baron, *Ford Instrument Co., Long Island City* 1, *N. Y.*

Dimensional stability of

PLASTICS AT HIGH TEMPERATURES

Previously unpublished data on shrinkage of thermosetting molded plastics after thermal aging

By J. CHOTTINER
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Pittsburgh, Pa.

IF the dimensional stability of a plastic is known, effects of thermal aging can be compensated for when a part is designed. Here, for the first time, are data on the dimensional stability of eight resin-filler combinations of thermosetting molding materials.

Materials: The eight resin-filler combinations tested represent those compounds generally used for commercial applications. These phenolic, melamine, and polyester resins, with a variety of organic and mineral fillers, range from general-purpose to high-impact and heat-resistant types. Resin-filler combinations are listed in Table 1. Because of their common usage, more than one material was tested of the phenolic-wood flour, phenolic-mineral-wood flour, and phenolic-mineral types.

Test Method: Six test bars, ½ by ½ by 5 in., were molded from each material in accordance with ASTM standards and supplier's recommendations and measured longitudinally at room temperature.

Two bars of each material were thermally aged at 75, 125, and 150 C for approximately 5000 hr. Length was measured periodically to the nearest 0.0005 in. after the bars had cooled to room temperature. Thermal aging was then continued until little or no additional shrinkage could be measured.

Dimensional changes were calculated as inches of shrinkage per inch of bar length and plotted as a function of thermal-aging time as shown in the accompanying curves.

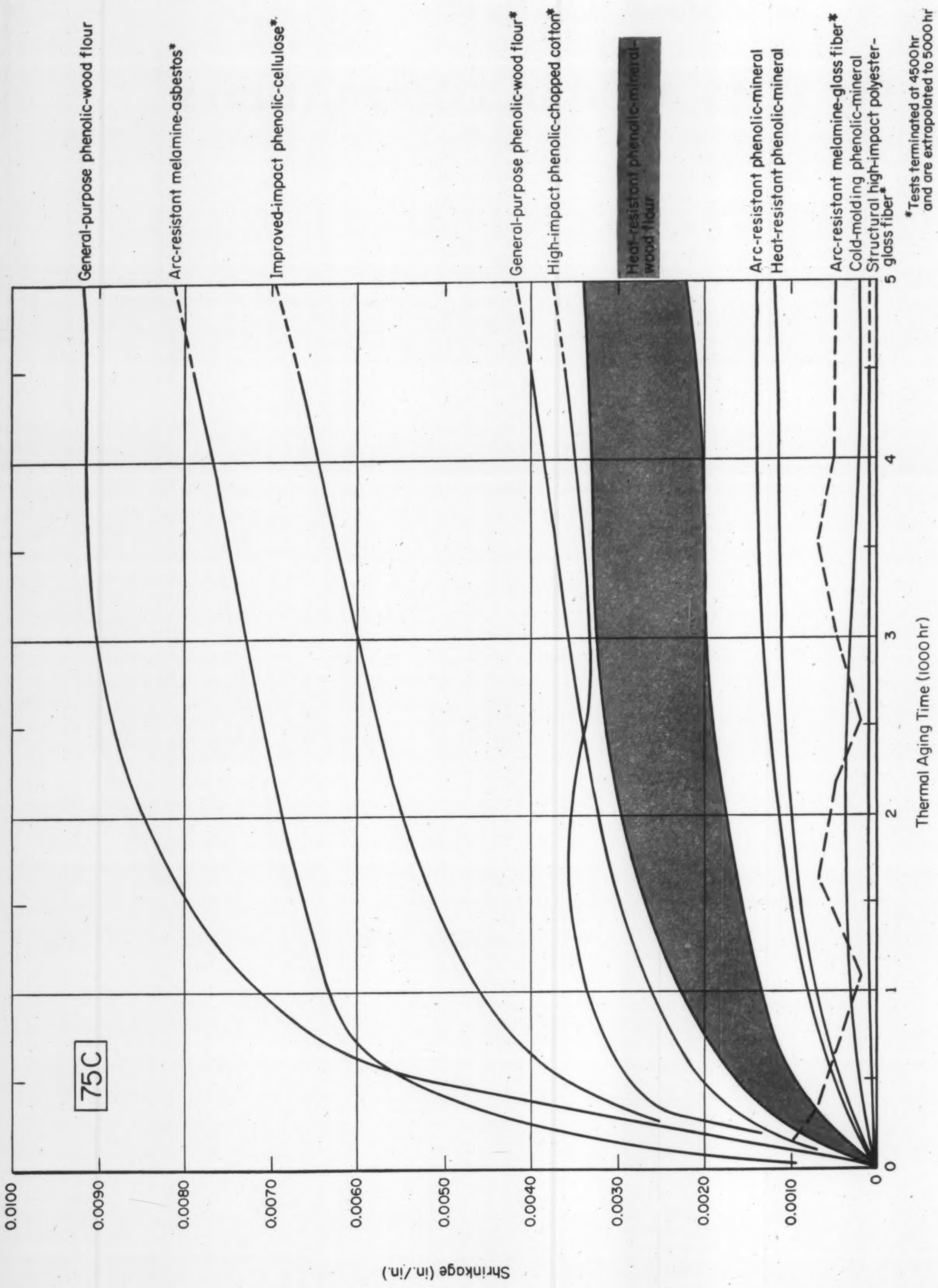
Results: For all materials tested, shrinkage occurs rapidly between 0 and 750 hr and, in most cases, increases uniformly and gradually to 5000 hr. An indication of the rate of shrinkage for each material during these time periods is given in Table 1 together with relative dimensional stability.

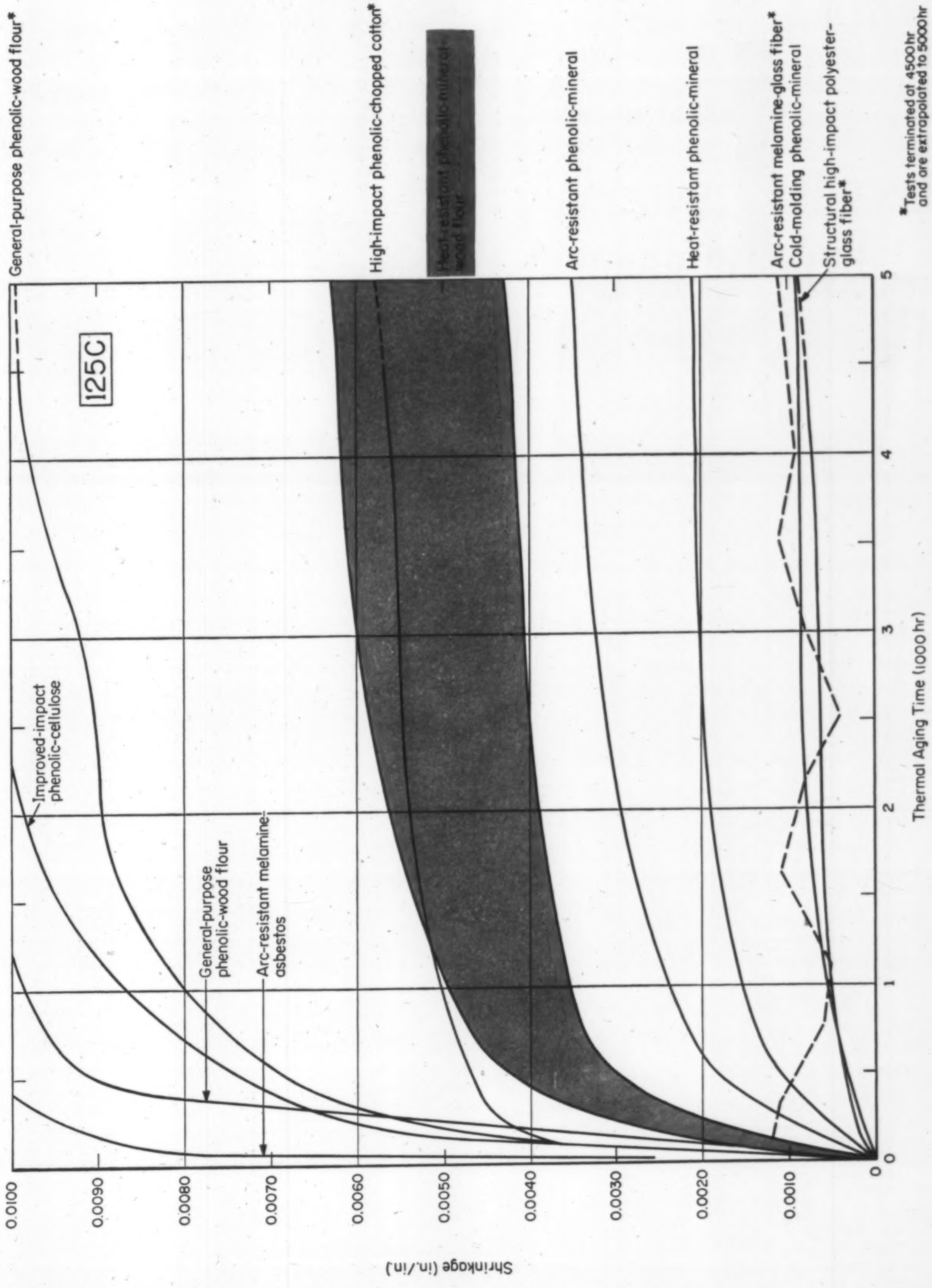
Actual shrinkage of each material at 75, 125, and 150 C is shown on the graphs at different thermal-aging times.

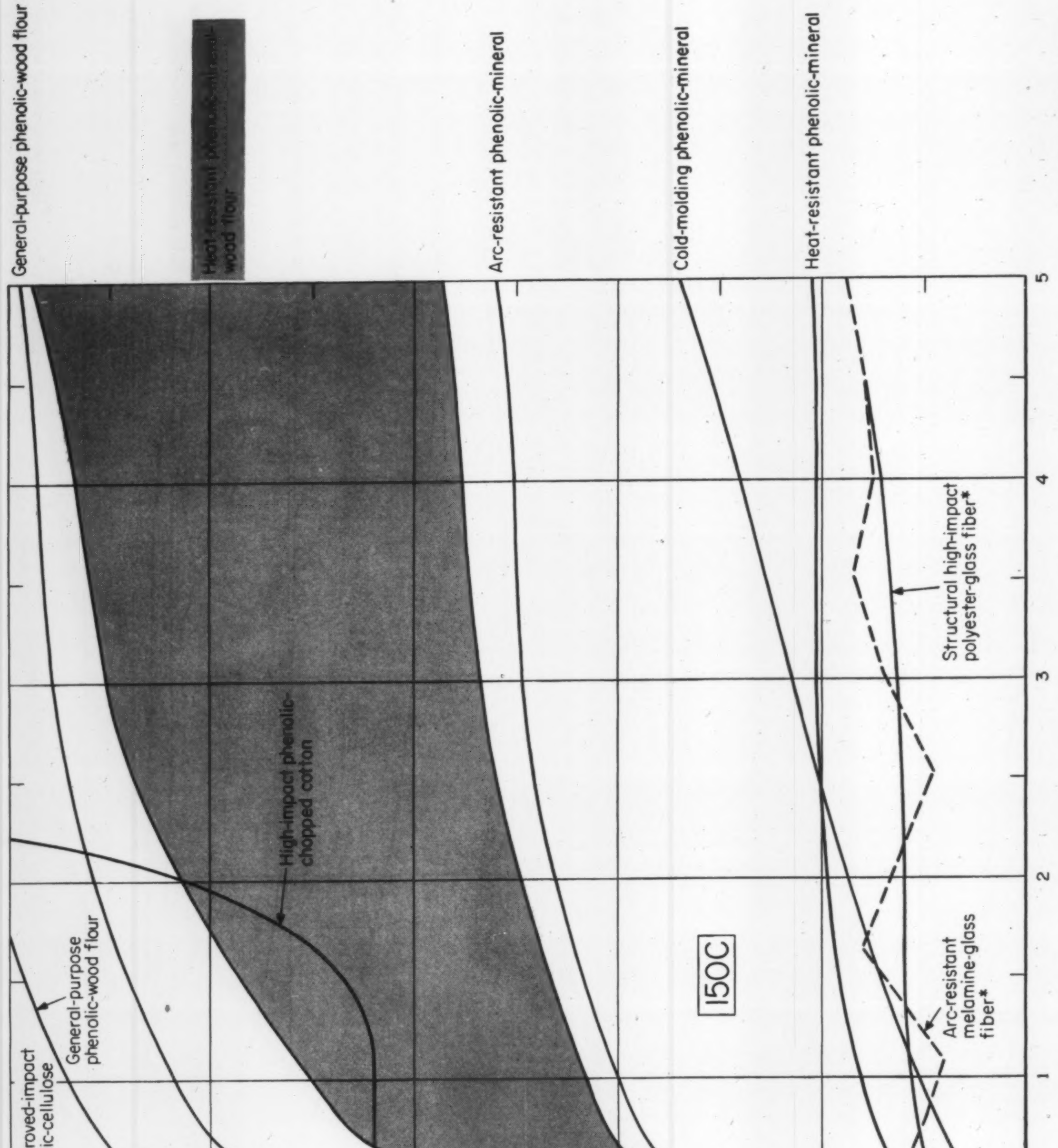
Table 1—Stability of Plastic Molding Compounds

Resin-Filler	Rate of Shrinkage (at 75 C)		Relative Dimensional Stability		
	0 to 750 hr[1]	750 to 5000 hr	At 75 C	125 C	150 C
Phenolic-wood flour	High	High	Fair to poor	Poor	Poor
Phenolic-mineral-wood flour	High	Low	Fair	Fair to good	Poor to fair
Phenolic-mineral	High to low	Low	Good to excellent	Good to excellent	Fair to good
Phenolic-cellulose	High	High	Poor	Poor	Poor
Phenolic-cotton	High	High[2]	Fair	Fair	Poor[3]
Melamine-mineral	High	High	Poor	Poor	Poor[4]
Melamine-glass	High	Low	Good[5]	Good[5]	Good[5]
Polyester-mineral	Low	Low	Excellent	Excellent	Good

1. Period of most shrinkage. 2. Excessive warpage, test stopped after 3000 hr. 3. Unstable after 1600 hr. 4. Unstable after 3000 hr. 5. Alternate shrinkage and expansion occur periodically.


75C
Shrinkage (in./in.)
0.0100
0.0090
0.0080
0.0070
0.0060
0.0050
0.0040
0.0030
0.0020
0.0010
0
Thermal Aging Time (1000 hr)
0
1
2
3
4
5
General-purpose phenolic-wood flour
Arc-resistant melamine-asbestos*
Improved-impact phenolic-cellulose*
General-purpose phenolic-wood flour*
High-impact phenolic-chopped cotton*
Heat-resistant phenolic-mineral-wood flour
Arc-resistant phenolic-mineral
Heat-resistant phenolic-mineral
Arc-resistant melamine-glass fiber*
Cold-molding phenolic-mineral
Structural high-impact polyester-glass fiber*
*Tests terminated at 4500 hr and are extrapolated to 5000 hr


125C
General-purpose phenolic-wood flour*
High-impact phenolic-chopped cotton*
Heat-resistant phenolic-mineral-wood flour
Arc-resistant phenolic-mineral
Heat-resistant phenolic-mineral
Arc-resistant melamine-glass fiber*
Cold-molding phenolic-mineral
Structural high-impact polyester-glass fiber*
*Tests terminated at 4500hr and are extrapolated to 5000hr
Improved-impact phenolic-cellulose
General-purpose phenolic-wood flour
Arc-resistant melamine-asbestos
Shrinkage (in./in.)
0.0100
0.0090
0.0080
0.0070
0.0060
0.0050
0.0040
0.0030
0.0020
0.0010
0
1
2
3
4
5
Thermal Aging Time (1000 hr)



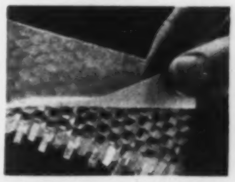
*Tests terminated at 4500 hr and are extrapolated to 5000 hr

THREAD-THIN contact is all that's required to bond the open end of the thimble. The adhesive used here holds fast at over 5000 psi in overlap shear (aluminum-aluminum); makes load-bearing honeycomb sandwich structures practical.

FROM 3M RESEARCH

Adhesives that meet bonding problems "edge on"

3M research-developed adhesives can hold over 600 pounds on the rim of a thimble. Industry is putting this strength to work in hundreds of ways.



AIRCRAFT WINGS, for example, are being built of lighter, far stronger honeycomb sandwich structures, thanks to 3M Composite Film Adhesives. These dry adhesive films turn liquid, then cure under bonding heat. Their remarkably high peel strength holds wing skin and core intact for the life of the plane.

THESE SAME WINGS are coated with other 3M products—erosion-resistant coatings. They protect the leading edges from the destructive blast of rain and dust at supersonic speeds.

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. . . WHERE RESEARCH IS THE KEY TO TOMORROW

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DESIGN ABSTRACTS

Hardware-design checklist for

Improving Electronic-Equipment Reliability

By H. I. DWYER Jr.
Reliability Followup Group
Bendix Aviation Corp.
Mishawaka, Ind.

MANY problems in reliability of electronic equipment can be traced directly to inadequate mechanical design. The resulting "hazards" introduce both direct and indirect reliability degradation. Some of these hazards are introduced during the design stage of the equipment, while others appear as a result of the inevitable changes brought about by testing and production.

Carefully planned checklists used in mechanical-design reviews assure attention to all critical areas and hazards. The following list was developed as a result of experience with various types of complex electronic equipment. Hazards were carefully chosen on the basis of possible danger and relative frequency of occurrence. Because no one list can describe every possible hazard, designers should use this list only as a foundation for developing a guide for specific components.

Covers, Doors, and Closures

1. Inadequate identification as to purpose and/or compartment or item covered.
2. Cover, and opening covered, not easily accessible from normal working position, or too small to permit easy access to compartment. Compartment not clearly visible when cover is removed.
3. Removable closures, plugs, and small covers not permanently attached to prevent loss. If attached, chain or other link not long enough to enable closure to be placed safely out of the way.
4. Inadequate hinges. Cover not securely held at all necessary positions.
5. Sharp corners or projections exposed when cover is opened.
6. Interlocks and/or automatic disconnects not provided for high-voltage areas.
7. No positive lock to ensure tight closing. Locking method does not provide rapid and positive visual check to determine if cover is closed and locked.
8. Seals and gaskets subject to damage by tools or abrading action of cover.
9. Covers and doors used for servicing not easily and quickly opened. Covers not keyed or shaped for installation in correct position only.
10. Openings left when regular covers are removed for shipping, test, etc., not covered by temporary closures to prevent introduction of foreign material.
11. Caps and plugs capable of abrading or wearing thus introducing foreign material.

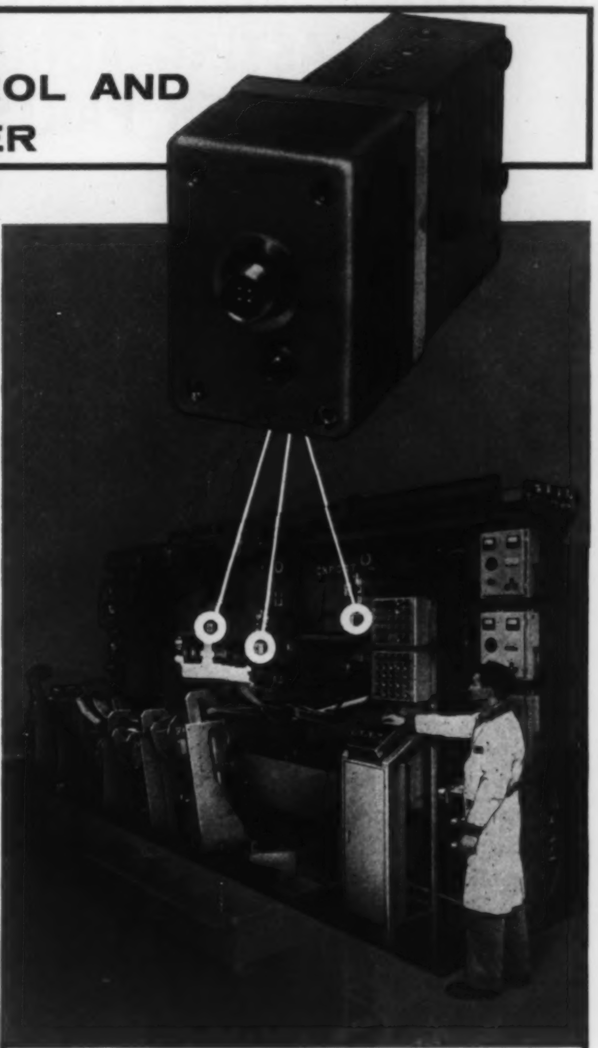
Tags, Warning Placards, and Markings

1. Stenciled or decal markings not protected from effects of moisture, abrasion, corrosion, and fading.
2. Service instructions not given or not placed adjacent to service point.
3. Serial numbers and other markings peculiar to one particular unit placed on dust covers or other frequently removed parts.
4. Markings in any area not oriented consistently or so oriented as to require extra effort to read comfortably.
5. Shape, size color, or contrast of markings does not promote rapid identification and interpretation under adverse conditions.
6. Lift points not positively identified and marked.
7. Sequence instructions not permanently marked on the unit where sequential assembly or disassembly operations are required.
8. Warning placards not used for high-voltage and other potentially dangerous areas.
9. Torque requirements not marked on the unit where torque is critical.
10. Closures, shipping clamps, and other items to be removed prior to use not clearly marked or such markings not clearly visible and identifiable when unit is ready for use.
11. Circuit reference for plugs, jacks, resistors, pots, tubes, etc., not clearly marked on chassis adjacent to the part to facilitate trouble shooting and maintenance.
12. Potted lines, diode assemblies, etc., not marked with circuit diagram and identification.

Cables, Connectors, and Cable Clamps

1. Cables taut, or strains on the connector, cable, or clamps. Insufficient clearance causes cable to chafe or bind on other parts.
2. Cables loose, or excessive lengths of

THE LINK BETWEEN ELECTRONIC CONTROL AND HYDRAULIC POWER



EXPERT WELDING MACHINE COMPANY developed this automated welding machine that incorporates a magnetic-tape-tracer system. Vickers electro-hydraulic servo valve provides the link between electronic programming and hydraulic power. Vickers Pumps and Controls also used. The machine joins metal parts having untrimmed, out-of-tolerance, straight and/or contoured weld line edges.

Expert Welding Machine Co. Solves the High Production Contour Welding Problem With

VICKERS

Electro-Hydraulic Servo Valve

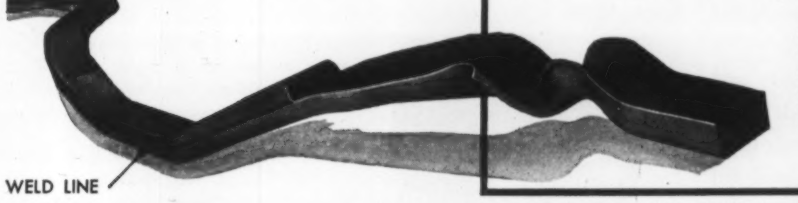
The versatility of electro-hydraulic control of power has solved one of industry's toughest problems—automatic welding of complex and contoured automotive frame members.

An electronic probe follows the weld line on the work and records any deviation from the path prescribed by a master cam. Any deviation from the governing cam contour creates an error signal which is amplified and fed to the servo valve. The servo valve converts these electrical signals into precise hydraulic flow to a cylinder which accurately positions the welding head allowing for variations in manufacturing operations . . . trimming, etc.

This application is only one of many in which Vickers Servo Valve has demonstrated exceptional performance under the exacting conditions of industrial production requirements.

Valve operation is simple. Reliability is assured—there are only four moving parts.

Investigate the production advantages offered by electro-hydraulics. **Write for Vickers Engineering Bulletin 58-74.**



Two U-shape channels are welded to form the box configuration in this complex automotive frame side member. Production is approximately 100 pcs/hr.

VICKERS INCORPORATED
DIVISION OF SPERRY RAND CORPORATION
Machinery Hydraulics Division
ADMINISTRATIVE and ENGINEERING CENTER
Department 1430 • Detroit 32, Michigan

8259

Application Engineering Offices: ATLANTA • CHICAGO* • CINCINNATI • CLEVELAND • DETROIT* • GRAND RAPIDS • HOUSTON • INDIANAPOLIS • LOS ANGELES AREA (El Segundo)* • MILWAUKEE • MINNEAPOLIS • NEW YORK AREA (Springfield, N.J.)* • PHILADELPHIA AREA (Media) • PITTSBURGH AREA (Mt. Lebanon) • PORTLAND, ORE. • ROCHESTER • ROCKFORD • SAN FRANCISCO AREA (Berkeley) • SEATTLE* • ST. LOUIS • TULSA • WORCESTER • Factories also in: Australia, England, Japan and Germany • In Canada: Vickers-Sperry of Canada, Ltd.. Toronto,* Montreal and Vancouver

Field Service Headquarters Underlined. Whse. Stock & Repair Branches*.

ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921

BRIDGEPORT FORGINGS END "CASTING ABOUT" FOR BETTER PARTS

The benefits offered by forging in producing parts of virtually any size, far outnumber the advantages of other methods. Forgings have approximately 150% more strength than comparable castings, superior gas, air and water tightness; smooth fine-textured surface finishes; thinner walls with greater strength — thus saving on metals costs; close tolerances that enable positive chucking, reduced machining time; which means fewer tools and longer tool life. Forgings, being free from porosity, inclusions or other flaws, also cut down on rejects and costly inspection time.

Bridgeport has the facilities and experience to produce a wide range of aluminum, brass and bronze forgings — conventional, cored, solid, flat die and hot pressed — for a multiplicity of parts and assemblies. Forgings are particularly recommended for parts of complex design — irregular shape. In fact, forging often is the only technique by which many intricate parts can be produced.

Bridgeport's long experience with forgings of every description prompts our offer of Technical Service to manufacturers and fabricators on any metal parts problem. We work closely with manufacturers and our service often results in both savings and product improvement. Our new booklet, "Bridgeport Forgings," will give you the facts about this service. May we send you a copy? Write Dept. 8902.

Bridgeport
Forgings

CORED FORGING DIVISION
BRIDGEPORT BRASS COMPANY
1000 Connecticut Ave., So. Norwalk, Conn.
Specialists in Metals from Aluminum to Zirconium

cable disposed around unit with possible interference or vibration problems. Cable lies across fasteners or removable units.

3. More than one possible cable run or installation possible even though installed length is not obviously affected.
4. Cable run requires sharp bends or permits such bends.
5. Potting material susceptible to cracking, absorption of moisture, decomposition, etc. Insufficient test data to prove environmental resistance.
6. Cable layout and/or connector type permits connection to wrong plug.
7. Connection points not visible due to bulkheads or other interfering units.
8. Connectors not easily accessible to tools and/or hands. If spanners or other tools are required for installation and tightening, design does not permit full swing.
9. Weak or inadequate keying provisions on connectors. Keying can be forced or overpowered easily.
10. Inadequate protection for cables and connectors located near hydraulic drains, fuel fill points, lubricating system breathers, and other places where fuel or hydraulic spillage or fumes might be present.

Wiring and Terminal Boards

1. Wires taut. Strains on wire or connections. Proper placement of terminals not controlled or defined.
2. Excessive wire length causing loops or excessive length between supports. Wires across removable parts, fasteners, or adjustment points.
3. Insufficient clearance around terminal points to allow operations in the area without possible damage to wires.
4. Excessive number of wires on a single terminal.
5. Insufficient space between terminals to allow mounting parts.
6. Insufficient sleeving or insulation.
7. Inadequate grounding for circuits. Grounds made through nonconductive or high-resistance paths, or by screw or pressure connections which are not locked or safety wired.
8. Insufficient lacing on wire bundles. Wire bundles not tied down to chassis at intervals to prevent vibration and impact problems.
9. Wire bundles not formed to definite shape, thus putting extra strain on outer wires in the bundle.
10. Strain relief boards or other measures not incorporated in connectors to prevent direct stress on wire bundles and connector solder points during assembly and disassembly of the connection.
11. Heavy wires brought to small terminals.
12. Consistent color code not followed for wiring. Color code not compatible

Circle 503 on Page 19

Bridgeport Ultra Fine Grain Brass Strip Saves Siesta-Ware $2,400 a Year

Colorful Siesta-Ware is designed to create a holiday mood ...and so are the remarkable production savings realized by Benner Glass Company!

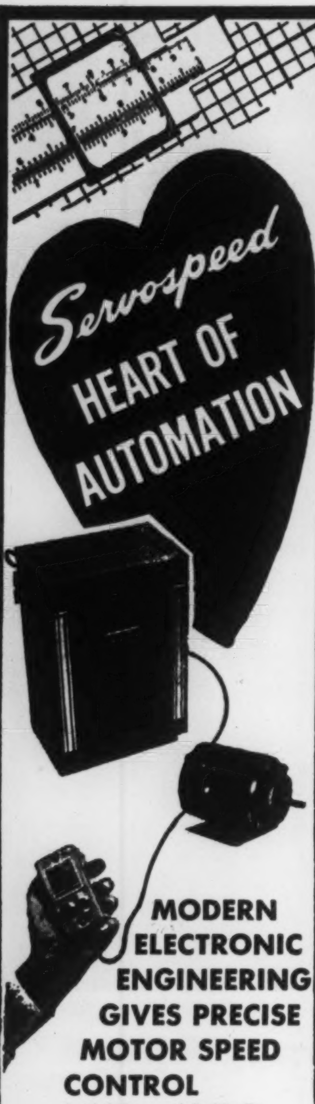
Before Benner Glass Company, Jacksonville, Fla., made the happy discovery of Bridgeport Ultra Fine Grain Brass Strip, production of the brass banding on each attractive Siesta-Ware Party Mug, Snack Jar and Tumbler was at the rate of two coils of strip running at 35 lineal fpm through three buffing stages. Today, with Bridgeport UFG Strip, the same machine runs *at the rate of 48 fpm!*

There's a simple reason why Benner Glass now realizes 23% time savings and 8% savings on polishing materials. It is this: the infinitely superior finish of Bridgeport Ultra Fine Grain Strip requires far less buffing. Important savings in time, cutting compound and buffing naturally result. In the annual processing of Bridgeport coiled strip, Benner saves more than $2,400... while turning out an even better finished product!

Don't *you* overlook the sizable savings that can be yours when you switch to Bridgeport Ultra Fine Grain Brass Strip. To get the facts and figures as they apply to your products, call *your* nearby Bridgeport Sales Office... or write direct for a copy of our Ultra Fine Grain Brass Booklet, GRAIN SIZE, THE FOURTH DIMENSION. Dept. **4302.**

Bridgeport BRASS CO.

BRIDGEPORT BRASS COMPANY
BRIDGEPORT 2, CONNECTICUT
Specialists in Metals from **A***luminum to* **Z***irconium*



MODERN ELECTRONIC ENGINEERING GIVES PRECISE MOTOR SPEED CONTROL

1/100 — 10 H. P.

Modern industrial electronic engineering has been coordinated with electric motor design to provide a versatile means for obtaining the full possible advantage of speed control in DC motors while operated from the regular alternating current power line. Grid controlled "Thyratron" tubes are utilized for power controlled stepless variation to supply motor armature power. Patented feedback, or "Servo" circuits provide constant torque capability over wide speed ranges of as high as 60 to 1 in some models and a minimum of 20 to 1 in others.

Servospeed
DIV. of ELECTRO DEVICES, Inc.
4 Godwin Ave., Paterson, N. J.
ARmory 4-8989

Circle 505 on Page 19

from chassis to chassis within an equipment or from unit to unit.

Fasteners and Hold-Downs

1. Insufficient clearance around fastener to allow placing tools during installation and removal. Insufficient space to move tools during installation or removal. If two parts must be held, both ends not visible from the same location.
2. Fastener placed so that loose parts or hardware, such as washers, can fall into the unit when the fastener is removed.
3. More than one type of fastener used in the same application. Different head sizes and types, and other differences requiring different tools for installation and removal used where a single standard type would serve. Number of types excessive.
4. Different lengths used where there is possibility of damage resulting from a part which is too long or too short.
5. Fastener too long or too short for the application. Bearing surface of bolt head, nut, or washer not adequate.
6. Locking devices inadequate or not specified.
7. Dissimilar metals used will cause galling or electrolytic corrosion.
8. Excessive lockwire run required due to layout of chassis.
9. Screw heads placed so that screwdriver must be tilted to clear other parts.
10. Recessed-head fasteners not readily identifiable as to type and size of recess.
11. Torque requirements not specified.
12. Spring clips and other types of clamps too large or too small for parts held by the clamp.

Small Parts

1. Parts exposed to damage by being mounted too close to places where screwdrivers and other tools are used.
2. Parts mounted so as to touch chassis or cover when cover is installed.
3. Inadequate or nonexistent clamps or hold-down for parts.
4. Solder points close to temperature-sensitive parts.
5. Parts mounted so as to require removal of other parts in case replacement is necessary.
6. Inadequate marking or identification on each part, or identification not readily determined.
7. Lead length required by layout is too long or too short.
8. Part mounting introduces dirt and and moisture traps under or behind the part.
9. Clamps or clips bear against soft or deformable surfaces.
10. Part layout does not conform as close-

PUMP DESIGN TRENDS
by Arthur A. Nichols

"BUILT-IN PUMPS" LOWER COSTS IN MANY APPLICATIONS

Designers of engines, compressors, machine tools, tractors, transmissions and other equipment requiring hydraulic systems can now build pump components integrally into these mechanisms . . . at a fraction of the cost of complete, separately purchased pumps.

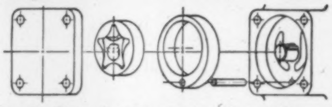


Fig. 1. Three Gerotor components permit pump to be incorporated as integral part of housing or frame of mechanism, eliminate need for purchase and mounting of separate, complete pump.

A three-piece insert package (Fig. 1.) makes this economical pump integration possible. Consisting of an inner and outer Gerotor and an eccentric locator-ring, the unit becomes a complete pump by simply boring the casting or frame of the mechanism to accommodate the locator ring O.D. and by providing porting. This design makes the main casting do double duty as the pump housing, thus eliminating a very considerable cost factor. A drive can be taken from any convenient shaft.

The resulting pump is a self-priming, positive-displacement, lightweight, valveless mechanism. It is long-wearing, and handles impurities in the fluid well. It can be made to pump in the same direction regardless of direction of rotation. It provides a relatively pulseless flow: volumetric and mechanical efficiencies are high; it is balanced and quiet in operation. *(Fig. 2.)*

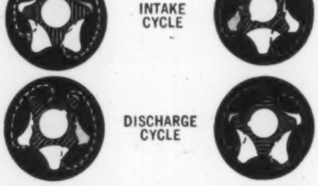


Fig. 2. Gerotor pump operating principle.

A wide variety of sizes is available covering capacities up to 100 gpm and 1,000 psi. Unlike complete pumps, the inserts are extremely flexible in adapting to various mechanism geometries.

The Nichols insert-package eliminates mounting pads, couplings, connectors, accessory drives and similar costly items and does away with buying finished pumps. Our technical assistance is available to you at all times and you are cordially invited to write for specific information on how this new concept can be adapted to your current designs.

W. H. NICHOLS CO.
38 Woerd Ave., Waltham 54, Mass.

Circle 506 on Page 19

Aircraft Components Manufacturer Specifies

OSTUCO Forged Tubing
FOR LOWER MACHINING COSTS

Forging tube end in Shelby mill. In addition, Ohio Seamless can supply tubing flared, swaged, expanded, upset, flanged, shaped, etc.

"Our machining time on this landing gear part in SAE 4140 plummeted from *400 to 180 minutes* when we changed from forgings to Ostuco Forged Tubing.

"In addition to getting *over 80% more parts per workshift*, we like the free-machining qualities of Ostuco tubing that give us extra savings in set-up time and tool grinding costs . . ."

These actual figures, from an eastern manufacturer, indicate the machining economies Ostuco Forged Tubing can effect in your product. The starting point is to call your nearest Ohio Seamless office, listed in the Yellow Pages, or the plant at *Shelby, Ohio — Birthplace of the Seamless Steel Tube Industry in America.*

AA-8850

Be Sure to visit Booth 205
Design Engineering Show
May 25-28, Philadelphia

OHIO SEAMLESS TUBE DIVISION

of Copperweld Steel Company • SHELBY, OHIO

Seamless and Electric Resistance Welded Steel Tubing • Fabricating and Forging

SALES OFFICES: Birmingham, Charlotte, Chicago (Oak Park), Cleveland, Dayton, Denver, Detroit (Huntington Woods), Houston, Los Angeles (Lynwood), Moline, New Orleans (Chalmette), New York, North Kansas City, Philadelphia (Wynnewood), Pittsburgh, Rochester, St. Louis, St. Paul, St. Petersburgh, Salt Lake City, Seattle, Tulsa, Wichita **CANADA:** Railway & Power Engr. Corp., Ltd. **EXPORT:** Copperweld Steel International Company, 225 Broadway, New York 7, New York

Circle 507 on Page 19

BEARING TIPS
by McGill

McGILL CAMROL®
bearings cost less to increase efficiency of cam follower, guide and support roller applications

Using CAMROL CF and CYR (cam yoke roller) bearings eliminates the inconvenience of obtaining and processing component parts for built up followers. It costs less to select the proper size CAMROL bearing from stock than machine and assemble loose bolts, bushings, bearings, and snap rings.

CAMROL bearings are engineered and precision built to carry heavier loads with greater accuracy and alignment. An extra heavy outer race with full roller complement on a flanged stud (or inner for CYR) offers high load and shock capacity. Smooth, dependable action with low starting friction is assured through longer machine life. Available sealed also.

Improved performance, reduced friction and greater accuracy as ram guides in huge welder

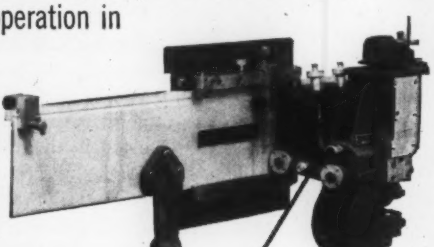
TAYLOR-WINFIELD

The long ram stroke and large diameter welding wheel impose severe requirements on the CAMROL equipped ram guiding device of this resistance seam welder manufactured by the TAYLOR-WINFIELD CORPORATION. The CAMROLS provide greater accuracy with less friction than was experienced with a round ram and bushing type bearing formerly used. Lubrication is simplified, maintenance reduced and performance is excellent.

The welder has a throat depth of 84" and a 12" vertical stroke of the upper ram carrying the large diameter welding wheel.

Ease of assembly and smooth operation in electrolimit continuous gage

PRATT & WHITNEY CO., INC., manufacturers of the ELECTROLIMIT CONTINUOUS GAGE shown here have cut costs through the elimination of built up followers requiring ball bearings, shafts, spacers and milling slots by using sealed CAMROL bearings. They are prelubricated and protected. The CAMROL bearings which travel along a vertical cross slide rail, provide smooth, easy action as the gage slides onto strip material running through the mill. No bearing replacement reported in over 10 years.



CAMROL® bearings take severe impact loads in hydraulic snubbing hooks

CAMROL CF bearings are used as hook positioner rollers in BYRON JACKSON HYDRAPLEX HOOKS. These heavy-duty (500-ton capacity) hooks are used in oil well drilling work. The hook positioner mechanism includes CAMROL cam followers that travel on a hardened cam track when the load is released to return the hook to its original position. The CAMROL bearings take severe impact loads in the thousands of pounds.

engineered electrical products

McGILL®

precision needle roller bearings

SEND FOR CATALOG No. 52-A

MULTIROL — GUIDEROL — CAMROL

McGILL MANUFACTURING COMPANY, INC., BEARING DIV., 200 N. LAFAYETTE ST., VALPARAISO, INDIANA

FROM BLUEPRINT TO TOP SELLER

Designed to match the famous "Peacemaker 45", P.Y. Hahn's CO_2 powered, 18 shot BB revolver took 45 days from blueprint release to production shipments of finished castings.

The two-piece barrel and the cylinder are zinc diecast in one shot. Die is designed to limit secondary machining to one ream operation and tapping four holes. Gas passages are as-cast. Casting surfaces have no ejector marks, which simplifies finishing operations.

Monarch Exploratory Engineering hit the bullseye in meeting the deadline for shipments against Hahn's heavy advance sales. Let us "trouble shoot" your casting problems.

MA

MANUFACTURING ACHIEVEMENTS in MOLTEN ALUMINUM

MONARCH ALUMINUM MFG. COMPANY

9205 Detroit Avenue Cleveland 2, Ohio

Circle 509 on Page 19

ly as practicable to functional arrangement.

11. Polarized parts, e.g., electrolytic capacitors, not identified as to polarity.

Brackets and Mounting Pads

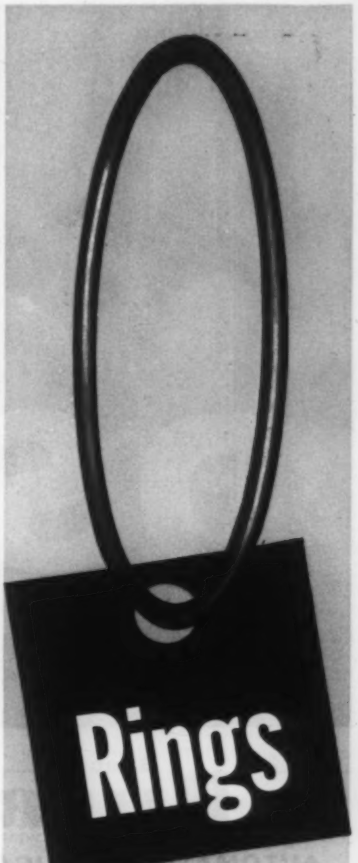
1. Nonsymmetric mounts not keyed in some way to prevent reversed installation of the mount.
2. Specialized brackets used where not required by function.
3. Cantilever mounting of large or heavy hardware on light brackets.
4. Flat mounting surface mated to curved surface or vice versa.
5. Brackets mounted on brackets.
6. Parts mounted on flexible or thin metal bulkheads.
7. Sharp bend-radius on angle brackets.

Adjustments, Test Points, and Controls

1. Inaccessible or hard-to-see from a normal working position or in poor light.
2. Inadequate locking provisions on adjustments.
3. Special tools needed for making adjustments or manipulating locking device.
4. Point not well clear of all other parts to prevent damage if prod or tool should slip.
5. Point not logically located with respect to function.
6. Insufficient identification or operating information available for operator or maintenance man.
7. Test points requiring special precautions not marked.
8. Direction of rotation or movement not consistent for similar functional changes.
9. Control knobs, switches, and other manual controls not placed and shaped to permit easy and positive control of movement.
10. Controls identified by arbitrary, ambiguous, or overly technical terminology.
11. "Press to turn," hoods, or other devices not used to prevent accidental tripping of switches and controls.
12. Test points carrying dangerous voltages not protected against accidental contact.

Removable Units and Assemblies

1. Positive provisions not incorporated to prevent incorrect installation and/or connection.
2. Inaccessible or hard-to-see hold-down provisions.
3. Number of hold-down devices excessive or insufficient.
4. Unit identification not positive as to serial number, type, model, modification, and purpose.
5. "Match fitting" units prevent interchange of functionally identical units.
6. Loose or unsecured pads, spacers, washers, or other hardware placed



by

LINEAR

in low-compression-set Butyl . . . for sealing problems involving the nonflammable phosphate esters.

LINEAR . . . specialists in close tolerance molding in all of today's elastomers.

Call on LINEAR for assistance with all your seal problems.

PERFECTION IN RUBBER

LINEAR

LINEAR, Inc. STATE ROAD & LEVICK ST. PHILA 35, PA

Circle 510 on Page 19

under the unit and held in place only by the unit.

7. Clearance between unit and other units or structural members does not allow for variations in size, or hinders installation and removal.
8. Inadequate lifting surfaces or handles provided. Where structure is intended to serve as a gripping surface, no marking to show where to grip.
9. Permanently attached cabling and wiring not long enough to permit complete removal of unit. No recess or well into which such cable can be placed when unit is in place.
10. More than one unit, not rigidly connected, must be removed at the same time or installed at the same time.
11. Contact between unit and bearing surface used for ground connection, or as common ground for two units.

General Considerations

1. Dissimilar metals used in contact or near proximity without protection for mating surfaces.
2. Exposed sharp or rough edges and corners.
3. Close dimensional or form control required for light sheet metal, plastics, or other material where such control is difficult.
4. Insufficient draft on castings, moldings, potted units, and other poured items.
5. Torsional loads carried by thin open sections or other flexible members where deflection is critical, or vibration or impact is encountered.
6. Stress concentrations present in the form of notches, small bend-radii, abrupt changes of cross section, etc.
7. Structure adequate for static loads but not for repeated or dynamic loads.
8. Insufficient bearing material for rivets, bolts, or other fasteners.
9. Dirt traps in the form of blind holes, corners, or pockets where foreign material or moisture can accumulate.
10. Insufficient drainage holes and paths.
11. Surface protection inadequate.
12. Mating surfaces capable of relative movement under load.
13. Inadequate thermal protection in the form of lagging, free-air circulation, and isolation of heat-producing parts.
14. No protection for fragile or easily misaligned parts against carelessness.
15. Parts mounted on bottoms of chassis able to come into contact with work bench or other surfaces.
16. Temperature of exposed surface can exceed 90 F during operation.

Preventive Measures

Complete layout of each section of the unit should be planned in detail before any final hardware is built. Consideration should be given to the idea of leaving space available

Specify
BIJUR
AUTOMATIC LUBRICATORS

For DSR
DESIGN, SERVICE AND RESEARCH
are part of every Bijur System

Consider Design — All Bijur pumps are designed to be an integral part of your equipment not a cumbersome attachment. Compact modern designs permit easy adaptation, enabling operation of the pump by means of gear, belt or chain drive or independently operated by electrical or hydraulic set-ups.

How you benefit — Custom-engineered Bijur automatic lubricating systems save production time and repair bills. Down-time and fire risks are sharply reduced. Costly hand oiling is eliminated and every bearing gets the right amount of oil when needed — there's no chance of under oiling or over oiling.

Day-in, day-out Bijur Systems are proving their value to designers, plant engineers and production men on the equipment they design, use, or manufacture. Write today for all the facts about Bijur automatic lubricating systems!

BIJUR AUTOMATIC LUBRICATORS—STANDARD EQUIPMENT IN MANY INDUSTRIES
Machine Tools • Business Machines • Printing Machinery • Textile Machinery • Food Product Machines • Bottling Machines • Packaging Machines • Sheet Metal Machines • Plastic Fabricating Machinery • Glass Products Machinery • Wood-Working Machinery • Industrial Sewing Machines • Special Process Equipment

B BIJUR
LUBRICATING CORPORATION
Rochelle Park, New Jersey
Pioneers in Automatic Lubrication

4341

Circle 511 on Page 19

electric motion control facts

for IDEA MEN

Electric motion control speeds automatic cycling

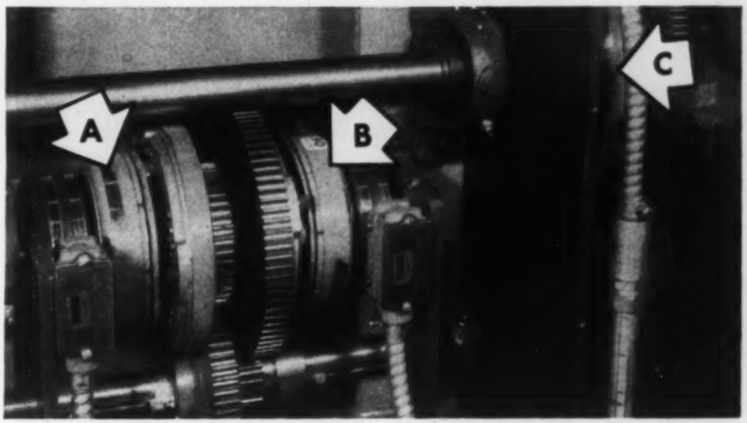


Fig. 2—Two Warner PC-500 electric clutches control wire feed roll. Armatures are mounted on drive pins to special hubs on slow- and fast-feed drive gears. Slow-speed clutch (B) is at the right, and fast-speed clutch (A) is at the left. Warner electric brake (C) assures precise stopping of roll for each index.

This manufacturer set out to design a rugged, dependable machine that would combine simplicity of operation, virtually foolproof electrical control, and flexible setup—for performing a sequence of rapid-fire operations on wire.

Three Warner electric brakes and two electric clutches played an important part in the design of machine elements which automatically measure, cut off, mark, and strip the ends of wire segments used in modern military aircraft and missiles.

Meet maintenance objective

The simplicity with which a series of complex operations could be controlled by electromagnetic rotary drives answered one of the major design requirements—easy maintenance. Use of the Warner units not only eliminated the need for brake and clutch adjustments, it reduced assembly costs, too. And, they provided the ideal answer for controlling fast starts and stops needed in the automatic cycle.

Control spacing to close limits

One step in the cycle is marking the wire at close intervals near both ends and at wider spacings for the rest of the run. Spacing is controlled by two Warner PC-500 feed clutches which engage the fast or slow gear train (see Fig. 2). The end stampings are made as wire moves at 6 in. per sec., with intermediate markings at 30 in. per sec. Fast, precise engagement and release of the clutches easily make extremely close spacings possible.

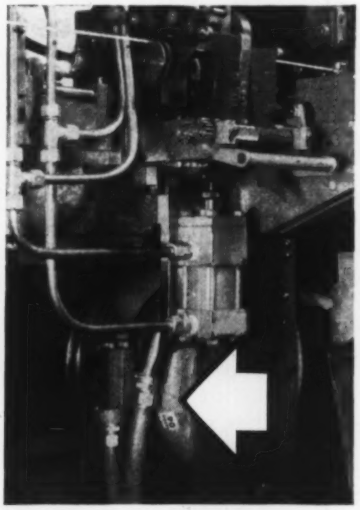


Fig. 1—The transmission that strips and cuts the wire is automatically controlled by the Warner PBC-825 electric clutch-brake.

Measure wire segments

For cutting wire to accurate segments, a Warner PB-825 electric brake controls the feed roll. This operation is so precise it exceeds the original specifications, measuring segments to a tolerance of plus or minus 1/16 in., even on longer lengths.

The transmission that cuts and strips the wire is actuated by a Warner PCB-825 clutch-brake (Fig. 1) which also actuates the timer and sorter to place wires in the proper slot at the completion of the cycle.

If you have a machine control problem, or want to find out how *electric motion control* can improve performance of your product, talk to your Warner representative or, write for our "IDEA ALBUM" examples of how electric brakes and clutches solved complex motion control problems.

Originators of electric motion control

WARNER

Warner Electric Brake & Clutch Co.

Beloit, Wisconsin

Please send: ☐ "IDEA ALBUM" Sheets; ☐ Catalog; ☐ Representative.

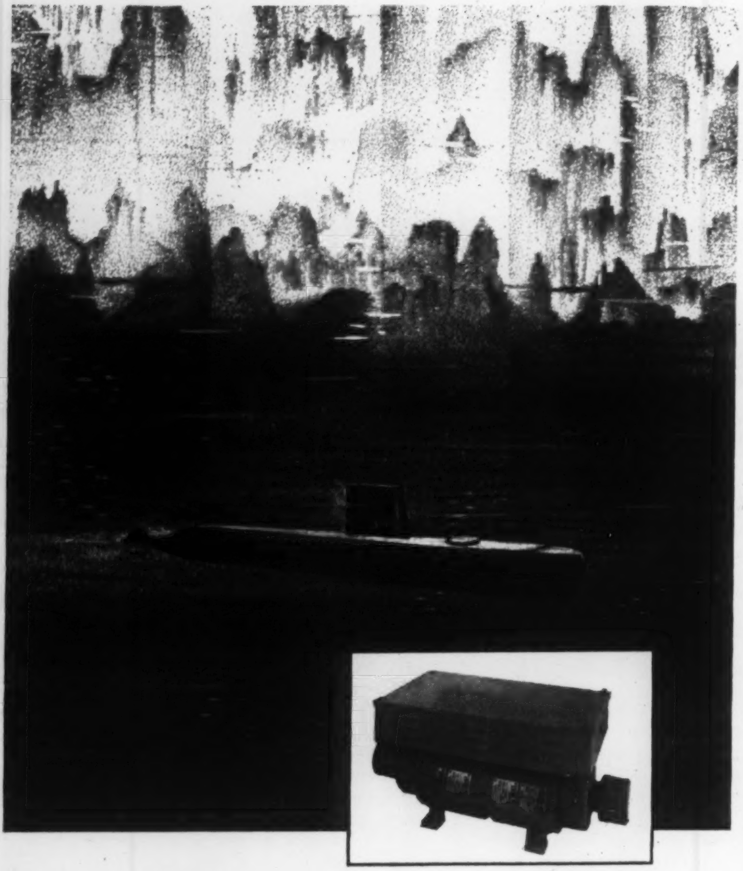
Name________________ Title________________

Company________________

Address________________

City________________ Zone______ State________

Circle 512 on Page 19



**ESCO standby power supplies . . .
when you can't take time
out for emergencies.**

Aboard the Nautilus, under polar ice or ocean depths, you can't take time out while you trouble-shoot power failures — specially in such a primary means of navigation as the Sperry Mark 19 Gyro-Compass system. It must keep track of heading and attitude for weeks at a time without interruption, and that calls for a foolproof standby power source.

For this exacting job, Sperry turned to a specially-designed ESCO motor-generator. Under normal conditions this standby equipment keeps emergency batteries charged from the regular 400-cycle 3-phase supply. But should this falter or fail, the ESCO unit immediately switches to emergency operation. The generator becomes a motor, and the motor a generator, to provide uninterrupted 400-cycle power for the Mark 19 from the emergency batteries.

The surest way to meet any exacting motor or generator problem is to specify equipment that's specifically designed for the job — ESCO equipment. *Write for design brochures today.*

See Esco Catalog in section 5a/EL in Sweet's Product Design File

ESCO
ELECTRIC SPECIALTY CO.

179 South Street, Stamford, Connecticut

Circle 513 on Page 19

to mount anything that might be required by revisions during development testing.

Full-scale orthographic and pictorial drawings should be prepared and checked closely. A full-scale mock-up, using either obsolete or dummy parts but including all wires, cables, bolts, and other assembled items, should be prepared with every part and removable unit placed and mounted as in the final design. A similar mock-up should be prepared and subjected to vibration, impact, sand and dust, and spray tests.

Design reviews should be conducted periodically during the development stage. Personnel involved in the review should include not only design engineers, but also manufacturing, quality control and inspection, test, operations, and maintenance specialists.

Complete design evaluation tests on engineering or prototype units should include functional tests under environmental conditions, interchangeability tests, and careful analytical inspections.

IRE paper, Proceedings of the Fifth National Symposium on Reliability and Quality Control (Electronics), Philadelphia, January, 1959; *pp.* 235-242.

Silver for Engineering Uses

RALPH L. WILCOX, American Smelting and Refining Co., New York, N. Y.

OF ALL the metals, pure silver has the highest electrical and thermal conductivity and the highest optical reflectivity. The following applications show how silver in a variety of forms is used for its unique combination of physical and chemical properties.

Silver Solders and Brazing Alloys: Silver solders are essentially ternary alloys of silver, copper, and zinc that flow freely at temperatures from 1145 to 1600 F. Silver content varies from 10 to 80 per cent. For special applications, many solders combine higher percentages of silver and additions of cadmium, phosphorus, and various other elements. Several lead-base or soft solders contain from 2.5 to 5.0 per cent silver where high strength is required.

Two new high-temperature applications for silver solders are in the rocket and jet-aircraft fields. Components such as heat exchangers, turbine blades, and honeycomb structures require a bonding material for joints that resists corrosion, severe shock, and vibration. Of the special silver solders developed, one is sterling silver of 92.5 per cent silver and 7.47 per cent copper. This solder contains approximately 0.03 per cent lithium for improved wetting and fluidity. Another solder contains 85 per cent silver and 15 per cent manganese. Silver-palladium and silver-palladium-manganese solders are also in use. Palladium improves strength and ability to wet iron and nickel-base alloys.

Silver solders are applicable wherever strong, ductile, and corrosion-resistant joints are necessary. Also, where the high temperature required for brass, nickel-silver, or copper brazing alloys would cause damage to metals to be joined, silver solders are recommended.

Electrical Contacts: Practically all electrical appliances use silver contacts in the form of plating, pure silver, silver alloy, or silver bonded to steel or copper. Contacts on high-voltage switching equipment are plated or otherwise use silver-to-silver contact surfaces. Electrical equipment which requires moving contacts uses sintered mixtures of silver or silver alloy and graphite. Recently, sintered mixtures of silver and cadmium oxide in the form of wire have shown promise for the manufacture of electrical contact rivets by cold heading. Improved performance without loss of conductivity is claimed. Contact resistance of silver is lower than that for copper and other commonly used materials. The corrosion product that forms is usually silver sulfide which is a conductor.

Silver is also used to coat fine copper wire to protect the wire during subsequent insulation with Teflon for high-temperature applications from 500 to 1000 F. Silver is plated on the wire in the amount of about 4 per cent by weight and

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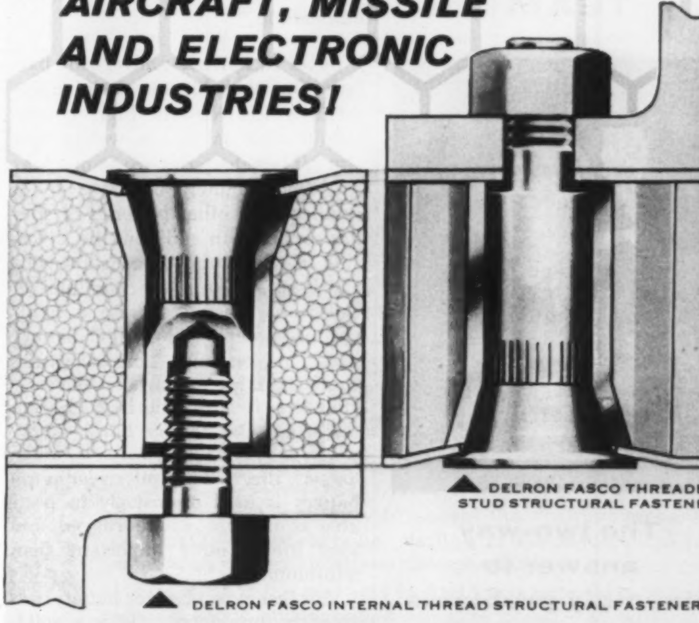

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▲ DELRON FASCO INTERNAL THREAD STRUCTURAL FASTENER

Illustrated above are two of the many new Delron structural design fasteners now available for Honeycomb and Sandwich Panels. • Write for engineering data.

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Circle 515 on Page 19

then the wire is redrawn before insulating. This special insulated copper wire is used for circuit work.

Ceramic Uses: Silver is used in the form of silver carbonate or silver chloride for ceramic-coloring preparations. Silver powder or flakes are used extensively with glass fluxes and metal compounds for conductors and electrode material for electronic ceramics. Circuits may be screen-printed or painted on ceramic discs or plates and fired at high temperatures to fuse the metallic silver compound and develop adherence to the ceramic. Such processes have been developed to the point where the entire operation can be done by automation.

Silver in Batteries: Silver-zinc batteries find their biggest use in equipment which requires high power-output with minimum weight and size. These batteries are as much as six times lighter and five times smaller than other batteries of similar capacity. In addition, the silver-zinc cell discharges at constant-voltage levels. The silver-cadmium rechargeable battery is also a lightweight, compact, long-life battery with performance characteristics similar to the silver-zinc battery. However, it is a little heavier than the silver-zinc battery but is somewhat more rugged with a much longer life. The silver-cadmium battery is used extensively in portable equipment where rugged and long life is more important than minimum weight.

Another type of silver battery was recently announced. It is a solid-electrolyte type made with silver, silver iodide, and vanadium pentoxide. This battery weighs less than 1 oz, has practically unlimited shelf life, and is designed for low-current applications. While its silver content is relatively small, the battery does represent a new industrial application for silver. Silver is also used in small quantities in industrial storage batteries for improved corrosion resistance and life.

Aircraft and Diesel-Engine Bearings: Silver is used in steel-backed aircraft and diesel-engine bearings and bushings where its excellent thermal conductivity is required. This type of bearing is made up of

HIGH SPEED, Sensitive Polarized RELAYS

"DIAMOND H"

SERIES P Relays

For electronic and communications applications

Engineered to provide extremely fast action with high sensitivity, freedom from bounce and excellent stability, "Diamond H" Series P Polarized Relays give consistent performance with low distortion. Under some conditions they will handle over 1,000 pulses per second.

Magnetically latched SPDT, with two independent coils, Series P Relays are available with various coil resistances from 10 to 4,000 ohms each coil. Contact ratings will vary with switching speeds desired, but range from 60 milliamperes to 2 amperes.

Extremely compact, to save space and weight, they fit standard octal sockets. Their impact and vibration resistance is excellent for relays of this type, thanks to extra-rugged construction.

"Diamond H" engineers are prepared to work out a variation to meet your specific requirements. Write or phone us your needs.

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Circle 516 on Page 19

WHAT'S YOUR PROBLEM?...

☑ Overheated motors?

☑ Excessive belt maintenance?

☑ Breakage of materials being processed —like thread, wire, paper?

☑ Expense of oversize or high torque motors?

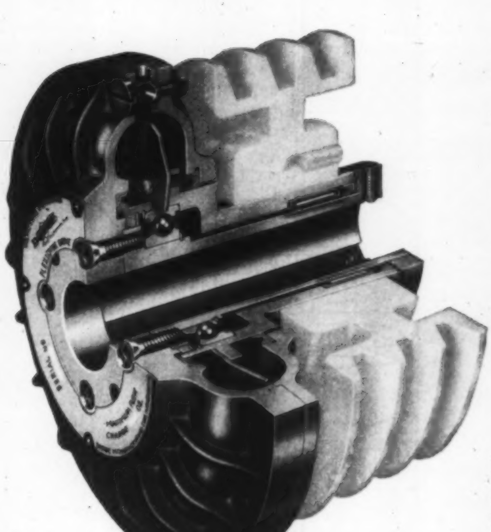
☑ High demand rate?

☑ Expense of reduced voltage starters?

☑ Clutch trouble?

☑ Breakage of transmission parts due to instantaneous shock loads?

☑ Damage and recurring down-time from overloads?



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THE DRY FLUID DRIVE

It is no longer necessary to accept the destructiveness—the costliness—of conventional starting in the mechanical transmission of power. Flexidyne changes that!

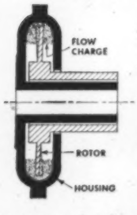
Flexidyne is the new way to start loads *smoothly*—to protect against shock and overload—to save power—all *without any sacrifice of efficiency at full load!*

This revolutionary development is ushering in "the day of the soft start"—which can mean thousands of dollars to you in equipment savings and in better, more economical operation.

Flexidyne is available, off the shelf, in Drives and Couplings. Capacities range from fractional to 1,000 hp. Ask your local Dodge Distributor or write us for technical bulletin.

DODGE MANUFACTURING CORPORATION, 3300 Union St., Mishawaka, Ind.

HOW FLEXIDYNE WORKS



The "dry fluid" in Flexidyne is tiny heat-treated steel shot. A measured amount, called the "flow charge," is contained in the housing, which is keyed to the motor shaft. Inside the housing is a rotor, free to revolve relative to the housing, but connected to the load.

When the motor is started, centrifugal force throws the flow charge to the perimeter of the housing, packing it between the housing and the rotor, which transmits power to the load. Initial slippage is momentary. Housing and rotor become locked together and achieve full load speed without slip and at 100% efficiency.

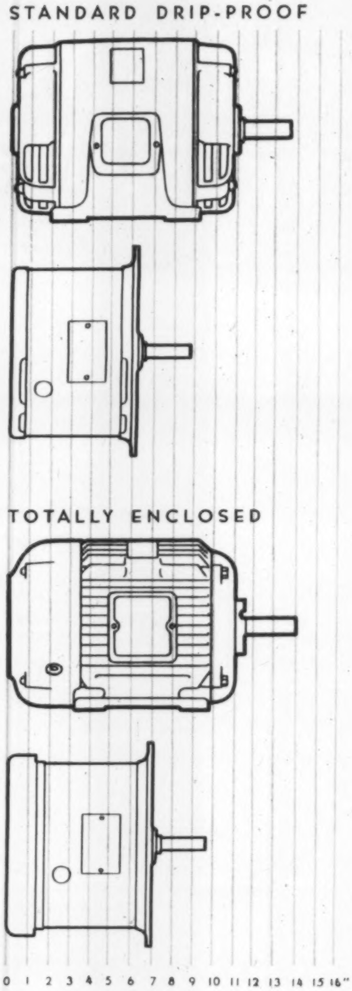
DODGE

of Mishawaka, Ind.

CALL THE TRANSMISSIONEER — your local Dodge Distributor. Factory trained by Dodge, he can give you valuable help on new, cost-saving methods. Look in the *white* pages of your telephone directory for "Dodge Transmissioneer."

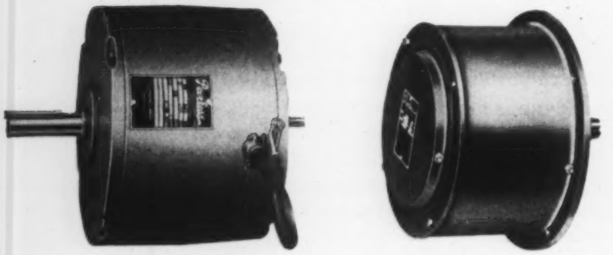
Circle 517 on Page 19

WHEN YOU NEED MORE MOTOR IN LESS SPACE



If your problem is how to put more motor in less space, this Peerless Space-Saver may be the answer. The line includes both drip-proof and totally enclosed designs in ratings from ½ to 10 HP. Bearings are pre-lubricated, double-shielded type. Peerless will work with you to build in any special requirements—torque, mounting, enclosure, duty, or insulation. Peerless Space-Savers cataloged in Bulletin SP-1 meet all NEMA performance standards.

Peerless is a specialist in OEM applications. Close cooperation with your engineers assures the development or selection of the one motor that powers your product. There's a Peerless sales engineer near you. If you don't know him, write to Peerless.



WRITE FOR Bulletin SP-1. It gives complete data on Peerless Space-Savers and lists nearby Peerless sales engineers.

Peerless
SPACE SAVER MOTORS

ELECTRIC MOTOR DIVISION
THE *Peerless Electric*® COMPANY
FANS · BLOWERS · MOTORS
1520 W. MARKET ST. · WARREN, OHIO

three layers: The first is a steel shell for strength, the second is a fine silver layer to conduct heat away from the third layer, or bearing surface, which is usually a lead-base alloy. Silver bearings and bushings are favored in diesel engines for certain applications. However, their use in aircraft has decreased with the advent of the jet engine. It is expected that silver bearings and bushings will be used to a large extent in passenger cars and trucks.

Atomic Energy Uses: Experiments have been conducted with an alloy containing nominally 80 per cent silver, 15 per cent indium, and 5 per-cent cadmium for control-rod material in pressurized-water reactors as a substitute for the more expensive and less available hafnium currently used. This alloy has excellent neutron capture characteristics, irradiation stability, high thermal conductivity, and excellent resistance to corrosion by hot water. However, initial tests indicate that creep strength is not as good as it should be.

From "Recent Developments in Industrial Demand for Silver," *National Western Mining Conference, February,* 1959; 9 *pp.*

techniques

Analysis of Complex Kinematic Chains

J. Modrey, Union College

Analysis of highly complex kinematic chains by means of simple vector equations involving influence coefficients. Influence - coefficient equations are related to superposition of simple kinematic chains. The technique for determining necessary influence coefficients is one of sequentially setting all variables but one to zero and relaxing appropriate constraints to maintain mobility. This "zero-relax" process creates a series of mechanisms, each simple enough to be solved by a direct process rather than by simultaneous equations. Analysis of velocities and accelerations for these simpler mechanisms yields the influence coefficients of the related but more

Compare NEW GLACIER DU WITH ANY OTHER DRY BEARINGS!

DU wears 10 to 100 times longer

DU has low breakaway torque . . . no slip-stick

DU has highest compressive strength—no cold flow

DU lets you predict minimum service life

DU is as close to the perfect dry bearing material as you will find today. It is a patented composite material consisting of a steel and porous bronze interlayer impregnated with a lead-filled TFE* fluorocarbon resin.

The compressive strength of DU is approximately 51,000 psi. DU is capable of operating at higher velocities than other dry bearings in many problem liquids and at temperatures from −328° F. to + 536° F. Thus DU is suitable for many applications ranging from liquid gas pumps and compressors to high temperature oven conveyor systems.

Most important, with DU the designer can quickly and accurately predict bearing life for specific applications. The unique characteristics of DU make possible establishment of curves relating bearing life to any load-speed conditions. These curves and other important design data are included in Bulletin DU-458. Ask your bearing manufacturer, or write to SPECIAL PRODUCTS DEPT., United States Gasket Co., Camden 1, N. J.

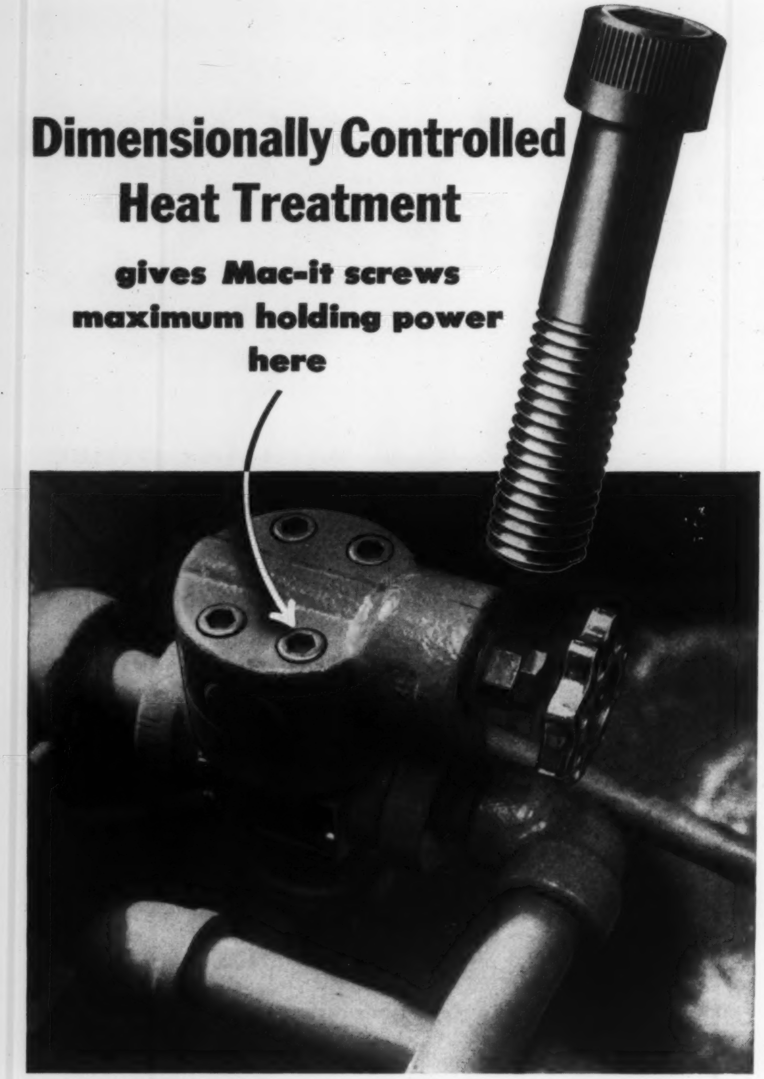
**Teflon, DuPont Trademark*
Fluon, I.C.I. Trademark

United States Gasket

Plastics Division of GARLOCK

Dimensionally Controlled Heat Treatment

gives Mac-it screws maximum holding power here



End-use requirement is an important factor in determining heat treatment specifications for Mac-it alloy steel screws. While physical dimensions are a prime factor, the proper combination of strength, toughness, ductility and resistance to shock and vibration must be achieved if the correct torque-tension—or holding power—is to meet your exact requirements.

Mac-it metallurgists determine a heat treating cycle that takes into consideration material, size *and* end use. This combination-of-three results in Mac-it screws with maximum holding power.

Every step in the manufacture of Mac-it screws is followed with care by specialists who know what you want—and want you to have it. That's why Mac-its *hold tight in a tight place!*

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NEW SPECIFICATION SHEET listing new 1960 Series Socket Screw Industry Dimension Standards. Write for your *free* copy.

Mac-it Parts Co., Dept. 21, Lancaster, Pa.

Mac-it ®

MAC-IT ALLOY STEEL SCREWS

Circle 520 on Page 19

highly complex mechanism.

The paper suggests several descriptive names which imply the quality of mechanism complexity. For example, systems of first-order complexity which refer to an arrangement of links whereby simultaneous equations can be solved in sequence are denoted as FOC systems. All systems possessing complexity higher than the first and which cannot be solved directly are termed SOC systems or those of second-order complexity. Emphasis is on higher-order complexity or HOC systems. These are chains which cannot be solved in sequence regardless of the choice of drivers.

It is proposed here that HOC systems be analyzed by a superposition of motion components of the system. These components may be selected at the analyst's will, hence, they most conveniently take the form of a series of FOC systems chosen to make the superimposed sum consistent with the known conditions of restraint. How to reduce an HOC system to several FOC systems is covered, and examples show use of the influence-coefficient technique.

ASME paper 58-A-74, *ASME Annual Meeting, New York, December,* 1958.

High-Range Plasticity of Metals Beyond Normal Work-Hardening

E. V. Crane and W. S. Wagner, E. W. Bliss Co.

An unfamiliar but potentially useful technique which provides data on metals for the high working ranges which lie beyond the point of normal tensile failure. This high range is distinguished by a deeper or more rapid rate of work hardening. Some use has been made of this phenomenon in rolling, cold extrusion, and shell drawing, but lack of adequate technical data concerning it is attributed to unfamiliarity with test programs. Here, a testing technique is outlined which provides engineers with the extended plastic-range data needed to plan production operation sequences. Since no single test procedure has been developed which gives a complete picture of this plastic range, it has been necessary to correlate a number of tests in a composite curve. This practice is based on the premise that the progressive increase in true stress with strain is essentially the same whether the metal is worked by drawing, rolling, extrusion, or other processes. Techniques for obtaining the extended plastic-range data are outlined.

ASME paper 58-A-132, *ASME Annual Meeting, New York, December,* 1958; 4 *pp.*

Thermal-Stress Ratchet Mechanism In Pressure Vessels

D. R. Miller, General Electric Co.

How to deal with the problem of cyclic heat flux through the walls of a vessel subjected to a sustained internal pressure. The combination of cyclic thermal stresses and sustained internal pressure is a source of progressive expansion of the vessel if stresses are sufficiently high. Formulas and curves applied in the analysis of a stress problem are useful in the following applications: 1. Pressure vessels subject to temperature transients in the contained fluid and heated internally or externally. 2. Temperature cycling of pressure vessels clad with material which differs from the base metal in coefficient of thermal expansion. 3. Bimetallic joints in pressure piping subject to flow cycling of temperature. 4. Temperature cycling of pressure vessels made of a metal consisting of crystal phases differing in thermal-expansion coefficient. 5. Turbine blades and discs subject to severe temperature transients and centrifugal loading. 6. Pressurized piping subject to high bending or torsional loadings. 7. High-speed aircraft components subject to combined thermal and mechanical loads. 8. Electrical conductors in motors subject to mechanical and thermal-expansion loads.

ASME paper 58-A-129, *ASME Annual Meeting, New York, December,* 1958; 5 *pp.*

TO OBTAIN COPIES of papers or articles abstracted here, write directly to the following organizations:

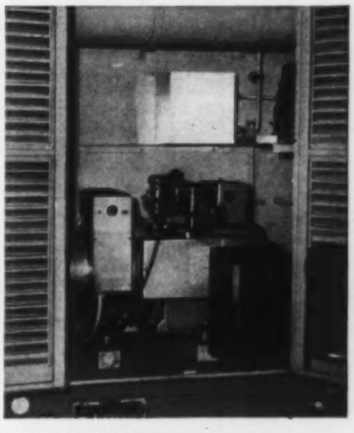
IRE—The Institute of Radio Engineers, 1 East 79th St., New York 21, N. Y.

ASME—American Society of Mechanical Engineers, 29 West 39th St., New York 18, N. Y.; papers 40 cents to members. 80 cents to nonmembers.

Onan NEWS REPORT

Mister Softee
CONES · SHAKES · SUNDAES

How to provide electric power for ice cream stores that move!



Onan 10KW, CW Series plant shows simple, accessible installation. Two-cylinder, gasoline engine is smooth-running and quiet.

***Mister Softee* mobile ice cream vans** are as fully electrified as a store with utility connections. Ice Cream freezers, air conditioner, lights, fans . . . even the heater that keeps "Hot Fudge" hot are operated by electric power.

The Onan 10KW electric plant supplies all current required with a generous reserve for future electrical loads. It is mounted at the rear of the truck in an easily accessible compartment. Onan's Vacu-Flo cooling keeps the compartment ventilated . . . delivers all heated air to the outside. Over 300 of these Mister Softee vans are now in operation.

Where you need electric power on mobile units . . . an Onan electric plant will provide service with dependability approaching that of the electric utility. 500 to 200,000-watt models. Gasoline or Diesel.

Need specific information for your particular job?
Call the Onan distributor listed in your phone book or write direct.

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Onan ELECTRIC PLANTS

Circle 521 on Page 19

assistant ENGINEER available

His name is STANPAT, and though he is not human he can swallow up your tedious re-drawing and re-lettering of standard and repetitive blueprint items for 24 hours a day if need be—without tiring. STANPAT is the remarkable tri-acetate sheet that is pre-printed with your specification and revision boxes, standard symbols, sub-assemblies, components and cross-sections . . . with adhesive front or back, waiting to be pressed into position in 15 seconds! Reproductions are unusually crisp and clear, guaranteed not to wrinkle, dry out or come off. STANPAT saves hundreds of hours in drafting time and money, allowing the engineer more time for creative work.

Already employed in numerous firms, STANPAT can go to work for you, too! Send us your drawing details now for quotation and free sample, no obligation.

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Circle 522 on Page 19

Helpful Literature for Design Engineers

For copies of any literature listed, circle Item Number on Yellow Card—page 19

Feed & Level Control

Entitled "Electronic Feed Regulator and Level Control," Bulletin 13552D covers the basics of control of feeders which are operated by electric motors or vibratory mechanisms. 6 pages. Industrial Instruments Inc., Cedar Grove, N. J. D

Circle 701 on Page 19

Pressure Control Valves

Operating principles, design features, and performance characteristics of a line of pressure control servovalves are detailed in illustrated Catalog 150. Cut-away view shows construction of this control for aircraft, missile, industrial, and other control systems. 6 pages. Moog Valve Co., East Aurora, N. Y. N

Circle 702 on Page 19

Circuit Breakers

Design and application data on small circuit breakers for use in electrical and electronic equipment and circuits are presented in illustrated bulletin. Many units conform to Military-Specs, and ratings range up to 50 amp. 8 pages. Wood Electric Co., 244 Broad St., Lynn, Mass. B

Circle 703 on Page 19

Electronic Components

Dimensions, performance characteristics, and technical data on capacitors, noise filters, power supplies, and other electronic devices are contained in illustrated catalog. 26 pages. Potter Co., 1950 Sheridan Rd., North Chicago, Ill. J

Circle 704 on Page 19

Centrifugal Switches

Syncro-Snap centrifugal switches can be used on devices utilizing rotary motion to provide speed regulation, governor control of maximum and minimum speeds, and limiting speeds for safety reasons. Performance and application data are given in Bulletin 244. 1 page. Torq Engineered Products, Inc., Bedford, Ohio. F

Circle 705 on Page 19

Midget Lamp Holders

Various types of miniature lamp holders for instrument dial, radio scale, toy, and other lighting, pilot, or indicating uses are depicted in data sheet. The Tiny-lite bulb measures only 9/16 in. overall in height. 2 pages. Drake Mfg. Co., 1711 W. Hubbard St., Chicago 22, Ill. I

Circle 706 on Page 19

Pressure Regulator

Detailed in Catalog Sheet II is the Fig. 8000 supersensitive pressure regulator pilot for regulating and reducing the pressure of steam, air, gases, and liquids within fractions of a pound in one stage. This pilot is used with ½ to 12-in. single or double seated valves. 2 pages. Atlas Valve Co., 280 South St., Newark 5, N. J. D

Circle 707 on Page 19

Machinable Carbide

Technical data on Ferro-Tic machinable cemented carbide are given in data sheet No. 12. Also presented are its physical properties and metallurgical characteristics. 1 page. Sintercast Corp. of America, 134 Woodworth Ave., Yonkers, N. Y. D

Circle 708 on Page 19

Miniature Bearings

Illustrated "Lubrication Manual" deals with the lubrication of miniature bearings for instruments and other precision equipment. Data and information are given on the various types and brands of oils and greases available to bearing designers and users. 28 pages. Miniature Precision Bearings, Inc., Precision Park, Keene, N. H. B

Circle 709 on Page 19

Belt Conveyors

Principal belt conveyor products of this company, including heavy duty and standard roller bearing and precision ball bearing idlers, are detailed in illustrated Catalog ID-591. Simplified and condensed information on the selection of belt conveyors and related equipment is included. Specifications of all equipment are given. 88 pages. Continental Gin Co., Industrial Div., Birmingham 2, Ala. A

Circle 710 on Page 19

Photo-Duo-Diode

Designed for operation to 125° C, the Type 1N2175 p-n-p 50-v, 250-mw diffused silicon photo-duo-diode has a maximum length of 0.600 in. and minimum lead length of 1.3 in. Specifications and typical characteristics are found in Bulletin DL-S 1044. 4 pages. Texas Instruments Inc., Box 312, Dallas, Tex. P

Circle 711 on Page 19

Magnetic Equipment

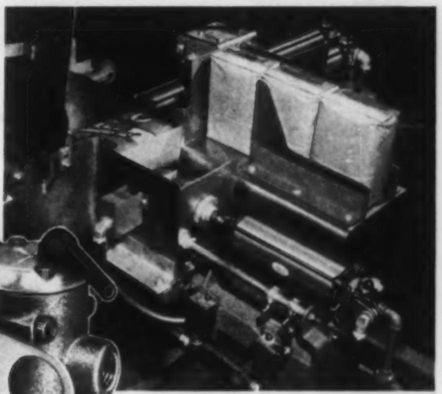
Hi-power permanent magnetic equipment to separate, retrieve, purify, and convey, and Hi-Vi Electro-permanent magnetic vibratory equipment to move and accurately feed bulk materials are described in detail and illustrated in plastic bound brochure. Specifications and engineering drawings are given for many pieces of equipment. 28 pages. Eriez Mfg. Co., Erie 6, Pa. F

Circle 712 on Page 19

with the

BELLOWS AIR MOTOR®

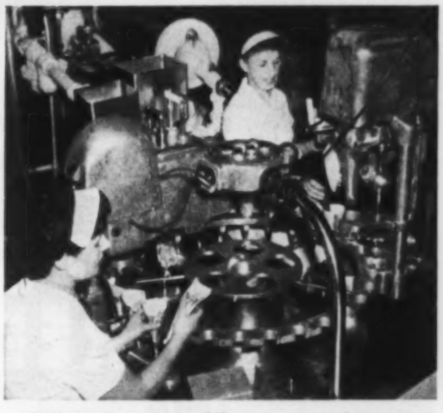
The Bellows Co.



Packaging coffee is simplified by this Bellows Air Motor powered equipment.

...you can build special machines ...or modernize existing machines *at low cost and quickly!*

With parts normally available in every tool room, plus one or more Bellows Air Motors, and a little creative ingenuity, you can "spot modernize" scores of operations whose high cost whittles away at profits. The few illustrated here are typical of hundreds we can show you. The chances are good that no matter what you make, nor how you make it, this versatile air cylinder, with its *built-in* electrically controlled valve, can lend a mighty important helping hand to your cost reduction program.

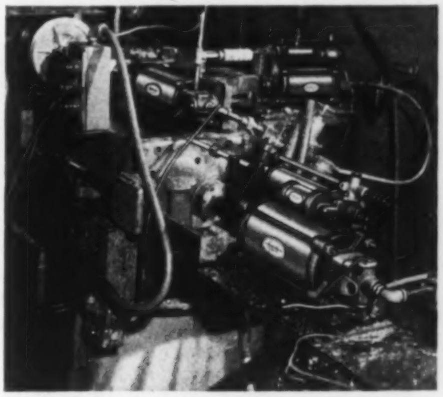


Bellows Air Motors fill ice cream, add nuts and fudge, fold and seal the wrapper in this special machine.

THIS FREE "SPOT-A-MATION FILE" MAY SPARK AN IDEA IN YOUR MIND THAT CAN MEAN IMPORTANT COST SAVINGS

A note on your letterhead addressed to Dept. **MD459,** The Bellows Co., Akron 9, Ohio, will bring you basic data: wiring diagrams, installation details, equipment list, on a score of "everyday" operations almost every industry uses—and, if you wish, the services of a Bellows Field Engineer, to help you adapt those ideas to your specific needs.

1313-B



Tail stock, tool bit, and cross-slide are moved by Bellows Air Motors in this lathe conversion.

The Bellows Co.
DIVISION OF INTERNATIONAL BASIC ECONOMY CORPORATION (IBEC)
AKRON 9, OHIO

OTHER INDUSTRIAL DIVISIONS OF IBEC: Sinclair-Collins Valve Co., Valvair, Akron, Ohio • V. D. Anderson Co., Cleveland, Ohio

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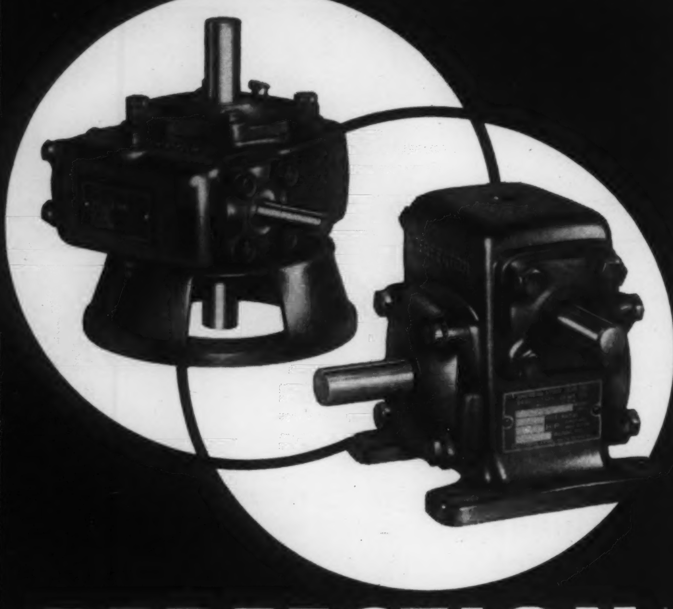

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worm gear
SPEED REDUCERS

available in ratios of
5 to 1 to 60 to 1

Perfection Worm Gear Speed Reducers by American Stock Gear are available in 9 complete series with ratios ranging from 5 to 1 to 60 to 1 for input revolutions ranging from 300 per minute to 1800 per minute. Speed Reducers are furnished in horizontal right angle drive with worm in either top or bottom position and are also furnished in vertical right angle drive. Integral worm and shaft is made of selected quality, case hardened alloy steel. Threads are precision ground and accurately mated with worm gear. Shafts are mounted in Timken anti-friction roller bearings. Heavy rigid cast-iron housings . . . easily accessible oil filling level and drain plugs are provided for oil reservoir. Oil seals are of selected cirvis leather which assures maximum sealing effect. Available through your nearest American Stock Gear Distributor.

Write for new 16 page catalog covering the complete PERFECTION Speed Reducer line.

AMERICAN STOCK GEAR DIVISION
PERFECTION GEAR COMPANY • HARVEY, ILLINOIS, U.S.A.

Circle 524 on Page 19

Load Isolator Magnets

Catalog Sheet 20 describes and illustrates Alnico V permanent magnets for microwave load isolators. Basic sizes and shapes of C Type magnets, plus engineering assistance available for design problems, are covered. 2 pages. Indiana Steel Products Co., Valparaiso, Ind. J

Circle 713 on Page 19

Switches

CX Series of raintight, explosionproof switches for fuel or chemical handling devices and other hazardous outdoor uses is subject of Data Sheet 156. Electrical capacity is 20 amp, 125, 250, or 460 v. 2 pages. Minneapolis-Honeywell Regulator Co., Micro Switch Div., Freeport, Ill. K

Circle 714 on Page 19

Silicone-Glass Cloth

Five bulletins describe various grades and types of glass cloths impregnated with silicone varnish and silicone rubber. They deal with properties and applications of glass tapes, fabric sheets, wrappers, and die-cut pieces. 2 pages each. Continental-Diamond Fibre Corp., Newark, Del. C

Circle 715 on Page 19

Electric Generators

Designed to provide electric power for a wide range of equipment, electric generators detailed in folder include 1500 to 10,000-w ac, 1500 to 5000-w battery charging, and 4000 to 12,000 belt-drive or power take-off tractor drive models. Controls and accessories are also shown. 4 pages. D. W. Onan & Sons Inc., Minneapolis 14, Minn. J

Circle 716 on Page 19

Induced Draft Fans

Design features, dimensional data, tables of recommended sizes of induced draft fans for oil or gas and coal firing, and rating tables for all available inlet diameters from 11 to 40 in. are found in illustrated Bulletin L-3. Capacities range from 694 to 68,344 cfm. 16 pages. Fuller Co., Lehigh Fan & Blower Div., Catasauqua, Pa. E

Circle 717 on Page 19

Air & Fume Hose & Duct

How Flexaust hose and Portovent Duct can be used to advantage in air handling and fume control are detailed in illustrated Bulletins 83 and 84. In addition to specifications, they contain 14 and 10 illustrated inserts, respectively, showing typical applications. Flexaust Co., 100 Park Ave., New York 17, N. Y. D

Circle 718 on Page 19

Helical Gearmotors

Construction features and applications of helical gearmotors and speed reducers are covered in word and picture in Bulletin GEA-6707. Cutaway drawings show maintenance features. 16 pages. General Electric Co., Schenectady 5, N. Y. C

Circle 719 on Page 19

400-Cycle AC Motor

Model C-2610 motor, a 400-cycle model with a normal operating range of 0.35 to 1.25 hp is subject of Data Sheet G-123. Rating at 22,000 rpm on 208 v, three-phase ac is 1.0 hp. Details are given. 2 pages. Hoover Electric Co., 2100 S. Stoner Ave., Los Angeles 25, Calif. G

Circle 720 on Page 19

Machine Unit Bearings

Dimensional data, including cross sectional drawings, are presented in Bulletin 4 on eccentric collar lock machine unit bearings with spherical seat and straight outside diameter. Load ratings are given in a table. 4 pages. Hoover Ball & Bearing Co., Ann Arbor, Mich. H

Circle 721 on Page 19

Oilers, Tubes & Valves

Specifications, general data, and dimensional drawings for a line of oilers, oil cups, vent tubes, tube forms, check valves, tube assemblies, and special assemblies are content of Catalog B-59. 12 pages. Eynon-Dakin Co., 9900 Freeland Ave., Detroit 27, Mich. H

Circle 722 on Page 19

Relays, Switches, Resistors

Brief descriptions of solid state and time delay relays, flasher, warning horn, switches, switch-lights, miniature resistors, panel light assembly, and relay junction box are content of illustrated folder. 4 pages. Pendar, Inc., Box 3355-EE, Van Nuys, Calif. L

Circle 723 on Page 19

Flexible Shafting

Advantages of designing a flexible shaft into products which require control from remote positions are outlined in Bulletin 539. Specification charts on remote control and power drive cables are included, along with casing materials information and uses of adapters. 8 pages. F. W. Stewart Corp., 4311 Ravenswood Ave., Chicago 13, Ill. J

Circle 724 on Page 19

Hydraulic Valves

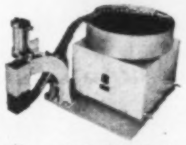
Details of two, three, and four-way hand operated and remote control hydraulic operating valves are given in illustrated Reference Book 39-6. Specifications for each model, optional features, capacity and piston speed-flow charts, and operating data are included. 20 pages. Homestead Valve Mfg. Co., Coraopolis, Pa. G

Circle 725 on Page 19

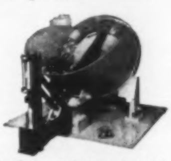
Timing Controls

Synchronous motor driven cam timers, multicam timer kit, time delay and interval timers, recycling timers, running time meters, and reset time totalizers are described in illustrated series of bulletins. Specifications of all units are given. Price sheets are bound into folder with bulletins. 26 pages. Industrial Timer Corp., 1407 McCarter Highway, Newark 4, N. J. D

Circle 726 on Page 19



VIBRATORY FEEDER for light, fragile or highly finished parts.



ROTARY FEEDER for high production feeding.

ROTARY HIGH SHELL FEEDER for maximum holding capacity.

Shuffle and deal parts for automatic assembly with DPS selective feeders

It takes fast, automatic feeding to satisfy the appetites of today's automatic assembly machines. And nowhere can you duplicate the range of equipment, the specialized experience in selective feeders offered by Detroit Power Screwdriver Company.

The most complete line in industry, DPS parts feeders include rotary, vibratory and elevator types. They handle any product from the tiniest of screws to assembly components the size of your fist . . . range in holding area from eighty cubic inches to 20 cubic feet.

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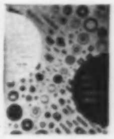

DETROIT POWER SCREWDRIVER COMPANY 15,036

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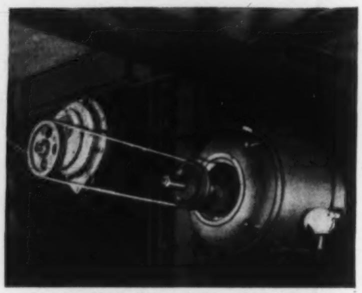
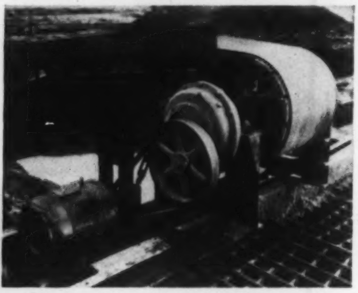
A Subsidiary of Link-Belt Company

Circle 525 on Page 19



Lovejoy Shaft Mounted Gear Reducer and Lovejoy Variable Speed Pulley provide an efficient, compact combination for driving a battery of drying vats. Simple adjustment of rod and turnbuckle maintains proper belt tension.



Speeds to meet sand and gravel production requirements are supplied through this Lovejoy Shaft Mounted Gear Reducer.

Save On Speed Reduction Costs

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GEAR REDUCER

COSTS LESS THAN OTHER SHAFT MOUNTED REDUCERS

ELIMINATES MOTOR BASES OR RAILS, SUPPORTING STRUCTURES, SHAFT COUPLINGS

Lovejoy's economical shaft mounted gear reducer keeps power transmission costs at a minimum. This rugged, compact unit is easy to install, easy to adjust—ends alignment problems and "extras" necessary for mounting and connecting conventional speed reducers.

It's a real space-saver, too. Mounts vertically or at any angle. Fits snugly into any drive arrangement. Provides greater flexibility in new equipment design, easy replacement in existing equipment.

Choose from 18 different models—all available from stock:

SPEEDS: 8 to 425 RPM
HORSEPOWERS: Fractional to 120
RATIOS: Single 4.5:1 Nominal
Double 14.7:1 Nominal

PROVIDES MAXIMUM EFFICIENCY (98% Double, 96% Single)

HOLLOW SHAFTS: 1 7/16" to 5 15/16"
ROLLER BACKSTOPS: available where protection against runback is required.
TORQUE REACTION BRACKET: furnished for units with platform-mounted or reversing drives.

Request complete information today. Write for Catalog R-58
Give application data for specific recommendations.

LOVEJOY FLEXIBLE COUPLING CO.

4818 WEST LAKE STREET • CHICAGO 44, ILLINOIS

Circle 526 on Page 19

Barrel Finishing Compounds

Barrel finishing compound selector chart simplifies the ordering of Chempound compounds, by showing the product recommended for any given finishing process on a wide variety of materials. 2 pages. Wheelabrator Corp., Techline Div., 1071 Ave. V, Vicksburg, Mich. H

Circle 727 on Page 19

Brazing Stainless Steels

Characteristics of base and filler metals, brazing cycles, selecting and using gas atmospheres, and construction and application of various furnace types are aspects of brazing discussed in booklet, "How To Braze Stainless Steel." Photos illustrate steps and equipment used. 24 pages. Harper Electric Furnace Corp., 39 River St., Buffalo 2, N. Y. N

Circle 728 on Page 19

Control Valves

Slim Line control valves which are only 1 in. thick by 3 in. wide are subject of illustrated Bulletin 581. They mount conveniently on any machine and can be manifolded into compact control centers. Three and four-way types are offered in 1/8 and 1/4-in. sizes. 4 pages. Hunt Valve Co., Salem, Ohio. G

Circle 729 on Page 19

Flexible Shafts

High speed power drive flexible shafts are described in illustrated Bulletin 590. Dimensional data and torque ratings in different bends, plus maximum operating speeds, are given. 2 pages. Stow Mfg. Co., 11 Shear St., Binghamton, N. Y. N

Circle 730 on Page 19

Electro-Mechanical Units

"Better Products for Automation Through Standardization" is title of illustrated booklet which outlines the adaptability of precision gears and allied components to a wide variety of design requirements. Such items as pin hubs, gears, drives, and other electro-mechanical parts are covered. 32 pages. PIC Design Corp., 477 Atlantic Ave., East Rockaway, L. I., N. Y. D

Circle 731 on Page 19

Strain Gages & Accessories

Specification and Price List 4310 deals with a complete line of SR-4 strain gages and accessories. Principles of operation, design considerations, and available products for stress analysis, materials research, and original equipment use are detailed. 24 pages. Baldwin-Lima-Hamilton Corp., Electronics & Instrumentation Div., Waltham 54, Mass. B

Circle 732 on Page 19

Wire Products

Iron, steel, and nonferrous wire for bookbinding, packaging, textile wire weaving, and other industries are among the Prentiss wire products described in illustrated folder. Properties and wire gage tables are included. 6 pages. H. K. Porter Co., Riverside-Alloy Metal Div., Riverside, N. J. E

Circle 733 on Page 19

Hydraulic Pumps & Motors

Suited for high temperature hydraulic systems, pumps and motors described in illustrated bulletin operate at speeds to 24,000 rpm and have efficiencies to 94 per cent. Performance and application information aids in selection of right size and type for a given job. 4 pages. Borg-Warner Corp., Pesco Products Div., 24700 N. Miles Rd., Bedford, Ohio. G

Circle 734 on Page 19

Miniature Ball Bearings

Conversion tables giving manufacturers' numbers for equivalent miniature ball bearings are included in bulletin on Filmoseal bearings which conform to ABEC-1 and 5 tolerances. 4 pages. Landis & Gyr, Inc., 45 W. 45th St., New York 36, N. Y. D

Circle 735 on Page 19

Tooling Plate

Aluminum tooling plate, described in illustrated bulletin, offers many advantages in the construction of industrial tools such as jigs and fixtures, press forms, layout tables, molds, patterns, and structural supports and bases. Design considerations and available materials are cited. 8 pages. Kaiser Aluminum & Chemical Sales, Inc., 919 N. Michigan Ave., Chicago 11, Ill. J

Circle 736 on Page 19

Compressed Air Filter

Details of a 600-cfh capacity compressed air filter for service up to 125 psi are given in data sheet. Filter is installed in air line and has ¾ or 1-in. pipe connections. 1 page. Dollinger Corp., Rochester 3, N. Y. N

Circle 737 on Page 19

Shear Fasteners

Reportedly 70 per cent stronger than present aircraft standards, two series of of shear fasteners offer savings in weight and space for applications to 550° F and to 900° F. Shear strength options are 132,000 and 156,000 psi. Details are given in Bulletins 2477 and 2478. 4 pages each. Standard Pressed Steel Co., Box 102, Jenkintown, Pa. C

Circle 738 on Page 19

Universal Joints

Prices, specifications, design data, and performance details on a line of single and double universal joints make up Catalog C-4. Included are a conversion table for static torque and horsepower at 100 rpm, and a decimal equivalent chart. 12 pages. Curtis Universal Joint Co., Birnie Ave., Springfield 7, Mass. B

Circle 739 on Page 19

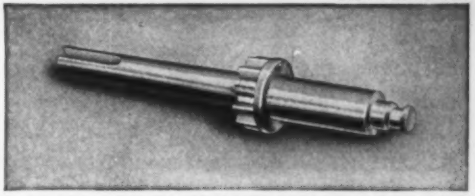
Handles & Locks

Locking and nonlocking plated door handles, plug removable locks, drawer and cabinet locks, and lock combinations are briefly detailed in Bulletin DH-1. Handles are offered nickel or chrome plated. 4 pages. Chicago Lock Co., 2024 S. Racine Ave., Chicago 14, Ill. J

Circle 740 on Page 19

here's PROOF of how the GRC method cuts the cost of small parts...

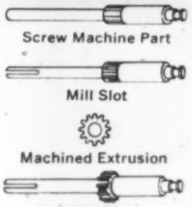
Shown actual size



Take, for example, this part which previously had been produced 2 different ways . . .

METHOD A

ASSEMBLY OF 2 SCREW MACHINE PARTS

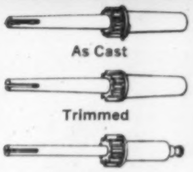


4 Production Steps

+ 3 inspections

METHOD B

CONVENTIONAL DIE CAST AND MACHINED PART



Machining for Undercut and Sizing of Diameters

3 Production Steps

+ 2 inspections

the GRC method

AUTOMATICALLY DIE CAST

1 Production Step

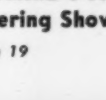
only **one** inspection

Now take a look at these comparative figures . . .

	Purchased Material	Cost/M	Scrap Generation	Cost in lots of 100 M	500 M
Method A	Brass	$30	30%	$70/M	$69/M
Method B	Zinc Alloy	$3.82	5%	$30/M	$28/M
GRC Method	**Zinc Alloy**	**$3.64**	**None**	**$15/M**	**$11.50/M**

Check the chart; you'll see clear proof of how GRC's DIE CASTING METHOD offers substantial savings on your small parts. The Gries Method delivers parts of high uniformity, with close tolerances . . . ready to use. Assembly and most other secondary operations are eliminated.

Write, wire, phone NOW for GRC's bulletin "Small Die Castings Exclusively"; send prints for quotation.



MAXIMUM SIZE 1¾" long, ½ oz. NO MINIMUM

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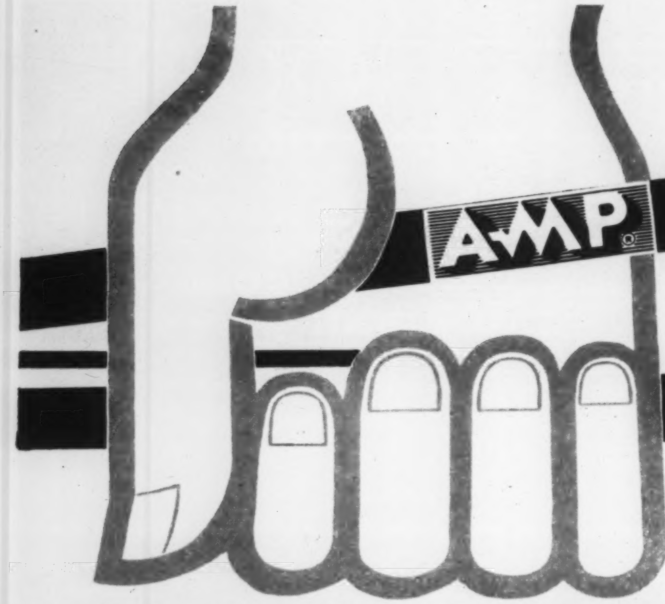
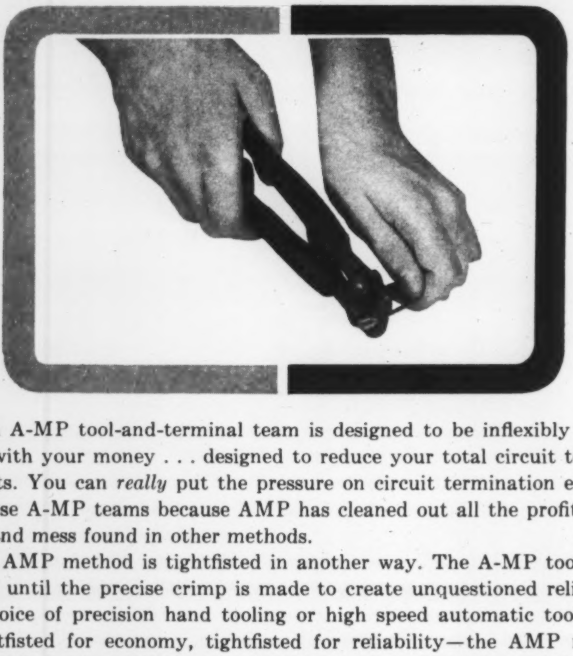
Circle 527 on Page 19



"TIGHTFISTED" TEAMWORK



Each A-MP tool-and-terminal team is designed to be inflexibly "tightfisted" with your money . . . designed to reduce your total circuit termination costs. You can *really* put the pressure on circuit termination expenses with these A-MP teams because AMP has cleaned out all the profit eating clutter and mess found in other methods.

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Circle 528 on Page 19

Welded Stiffeners

Design Ideas No. 21 is compilation of aids on the proper use of stiffeners. It shows how they can increase rigidity of weldments with minimum of material. 4 pages. Lincoln Electric Co., Cleveland 17, Ohio. F

Circle 741 on Page 19

Centrifugal Castings

Illustrated Broadside No. 157 deals with nonferrous centrifugal castings. Large fold-out chart lists specs, analyses, and properties of tin, aluminum, manganese, and silicon bronze; brass; Monel; and special alloys. Typical castings are shown. 8 pages. Shenango Furnace Co., Centrifugally Cast Products Div., Dover, Ohio. G

Circle 742 on Page 19

Nylon Stock Shapes

Nylatron GS, a molybdenum disulphide filled nylon, is available in wide range of shapes for mechanical and bearing applications, according to Bulletin BR-2. Properties and forms for use as gears, rollers, bearings, washers, wear strips, and other parts are covered. 4 pages. Polymer Corp. of Pennsylvania, Reading, Pa. C

Circle 743 on Page 19

Pipe Plugs

Ease of installation, tight seal, minimum of driving torque, and freedom from loosening are some of the features of Lok-Thread pipe plugs detailed in illustrated bulletin. Thread design which assures sealing properties is shown. 2 pages. Lock Thread Corp., 2832 E. Grand Blvd., Detroit 11, Mich. H

Circle 744 on Page 19

Pressure Regulators

Line of pressure reducing valves which provide dead-end shut-off and positive pressure regulation on steam, water, oil, gas, air, and chemical service is described in Bulletin J-160. Sizes of 1/4 to 2 in. are designed for pressures up to 250 psi. 6 pages. Jordan Corp., 6013 Wiehe Rd., Cincinnati 13, Ohio. G

Circle 745 on Page 19

Coated Abrasives

"The Abrasives' Workshop" is title of regular publication which will be sent to users or specifiers of coated abrasive products. Finishing techniques, data on abrasive products, and grinding equipment which uses coated abrasives will be content of this bimonthly booklet. 12 pages. Carborundum Co., Niagara Falls, N. Y. N

Circle 746 on Page 19

Magnetic Contactors

Bulletin 41-B2 points up application and design features of Class 41 magnetic contactors. Rated through 10 hp, 220 v and 15 hp, 550 v polyphase, units provide across-the-line control of motors, heating, and lighting loads. 4 pages. Furnas Electric Co., Batavia, Ill. I

Circle 747 on Page 19

Air Control Valves

An informative discussion of air valves and their selection, as well as condensed catalog listings of two, three, and four way and speed control air valves are included in Bulletin 234. Entitled, "Valve Finder," this guide contains full specs and design information. 12 pages. Hannifin Co., Dept. 116, 501 S. Wolf Rd., Des Plaines, Ill. J

Circle 748 on Page 19

Aluminum Die Castings

"The Inherent Characteristics of Aluminum that Influence Melting and Holding" is title of reprinted technical article. It emphasizes the importance of proper melting equipment and procedure. 6 pages. Apex Smelting Co., Chicago, Ill. I

Circle 749 on Page 19

Air & Hydraulic Cylinders

Described in Bulletin PSC-59 are air and low pressure, high pressure, Pemaco, automation standard air and hydraulic, and Powermaster air and hydraulic cylinders and accessory equipment. Dimensions and performance data aid in selection and application of these units. 16 pages. Petch Mfg. Co., 463 York St., Detroit 2, Mich. H

Circle 750 on Page 19

Solenoid Valves

Engineering data sheet, supplemented with seven dimensional drawings, describes solenoid valves for operating pressures up to 3000 psi. Valves are available for 110, 220, and 440 v ac service. 2 pages. Fluid Power Accessories Inc., Glenview, Ill. J

Circle 751 on Page 19

Welded Steel Tubing

Available literature consists of brochure on welded stainless, mechanical and boiler tubing; a weight chart for square and rectangular tubing; and a weight comparison table on welded steel tube versus solid bars. 8, 4, and 4 pages, respectively. Standard Tube Co., 24450 Plymouth Rd., Detroit 39, Mich. H

Circle 752 on Page 19

Flow Check Snubber

Pressures up to 30,000 psi are withstood by the Chemiquip flow check snubber, a device for preventing pressure instrument failure and hazard to plant personnel. It isolates instrument from the pressure transmitting medium. Bulletin 821 provides details. 2 pages. Chemiquip Co., 36 E. 10th St., New York 3, N. Y. D

Circle 753 on Page 19

Limit Switches

Line of industrial duty precision limit switches covered in Folder EA-154 is designed for applications requiring millions of operations. Units are rated up to 600 v ac and dc. Plunger, roller-plunger, 6-in. lever, and roller-lever actuated switches are described. 4 pages. Cutler-Hammer Inc., Milwaukee, Wis. K

Circle 754 on Page 19

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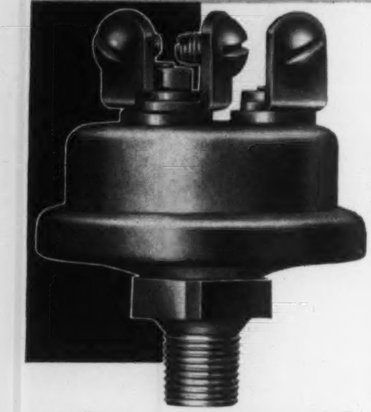
Circle 529 on Page 19

New! Hobbs dual CIRCUIT PRESSURE SWITCHES



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Actuates two electrical circuits . . . locks out one while the other is in operation. Ideal for operating instruments, warning signals, safety devices, fuel pumps . . . in many ways for making and breaking circuits. Can be used with oil or air . . . or, with standpipe, with most liquids or gases.

Available to pound setting specification in both circuits within ranges of 3-6, 7-14 and 15-60 psi. Compact — only 1-11/16" diameter. Pressure assembled and pretested at 150 psi. Designed for use on direct current.

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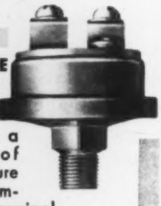

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Also available — a wide selection of single circuit pressure switches. Single terminal . . . double terminal . . . normally open . . . normally closed. Pressure ranges of 3-6, 7-14 and 15-60 psi.

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Circle 530 on Page 19

Axial Fans

Illustrated Bulletins J-614 and J-610 are descriptive of Axivane fans for aviation and electronic applications and Series 1000 Axivane fans for a wide range of air circulation purposes in commercial and industrial applications, respectively. Tables, charts, performance and design data, and other information are included for various sizes of these axial vane duct type fans. 12 and 72 pages. Joy Mfg. Co., Henry W. Oliver Bldg., Pittsburgh 22, Pa. I

Circle 755 on Page 19

Making Repair Parts

Helpful data Bulletin 21 tells "How to Make Your Own Machine and Repair Parts Quicker and Easier." It covers care and trouble-shooting of machines and equipment, machining and welding techniques, and contains drill hole tolerances and a grinding limits chart. 24 pages. La Salle Steel Co., Box 6800-A, Chicago 80, Ill. J

Circle 756 on Page 19

Printed Circuit Connectors

Continental printed circuit connectors described in folder have conveniently located test points to check circuitry in various applications. Single contact Series TJ and the Series 672 printed circuit test block connector are described with respective outline and mounting dimensions. 6 pages. DeJur-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y. D

Circle 757 on Page 19

Pressure Switch

Specification Sheet S 1011-3 covers the Pressuretrol, an industrial pressure switch which controls liquid or gas pressures up to 3000 psi. Unit can operate alone as a controller, or with other instruments for limit alarm or signalling service. 2 pages. Minneapolis-Honeywell Regulator Co., Industrial Div., Wayne & Windrim Avenues, Philadelphia 44, Pa. E

Circle 758 on Page 19

Motor Controls

Selection and ordering of motor controls are simplified by the wall-type Quick Selector Chart. Information covers controls are simplified by the wall-type Quick bers, and ordering instructions. 20 pages. Write on company letterhead to Arrow-Hart & Hegeman Electric Co., Industrial Control Div., 103 Hawthorn St., Hartford 6, Conn. B

Antennas

Revised and enlarged antenna handbook is a compilation of basic charts, graphs, and data on an extensive line of radar and microwave antennas. Losses, pattern tests, beam widths, range coverages, wave guide wavelengths, and much other data are included. Performance information is included. 28 pages. Available only upon letterhead request to I-T-E Circuit Breaker Co., 1900 Hamilton St., Philadelphia 30, Pa. C

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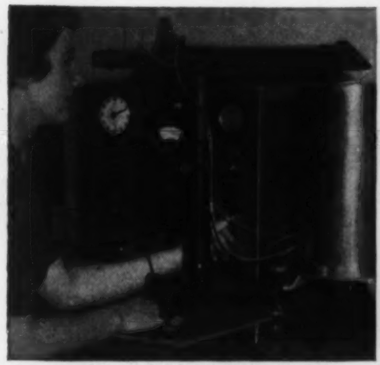
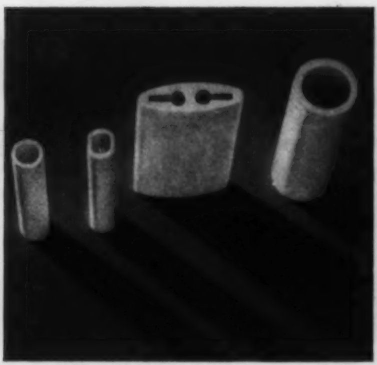
Philadelphia, Pa.—MOhawk 4-6749
Pittsburgh & Cleveland—Cleveland, ENdicott 1-5400
Chicago, Ill.—GLadstone 5-7850
Detroit, Mich.—TUxedo 4-2530
St. Louis, Mo.—SHerwood 1-6423
Greensboro, N. C.—BRoadway 3-5973
Los Angeles, Calif.—PLeasant 3-5531

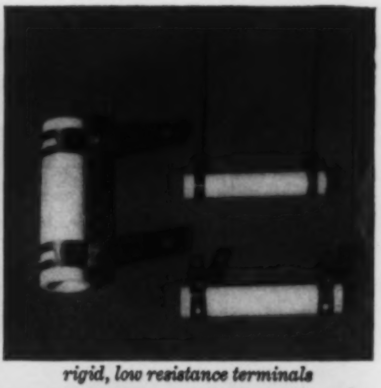
Circle 531 on Page 19



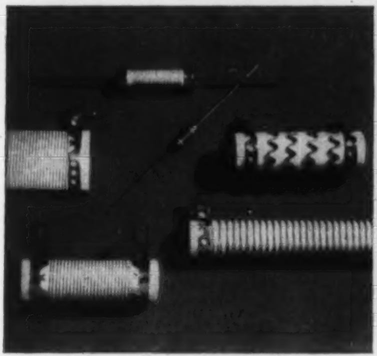
tough tests for incoming material



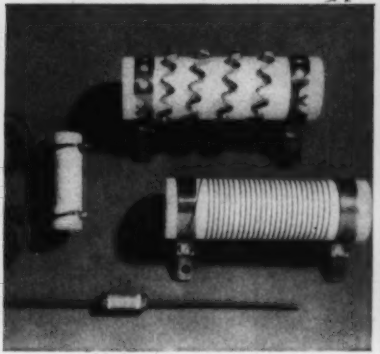
specially selected ceramic core materials



rigid, low resistance terminals

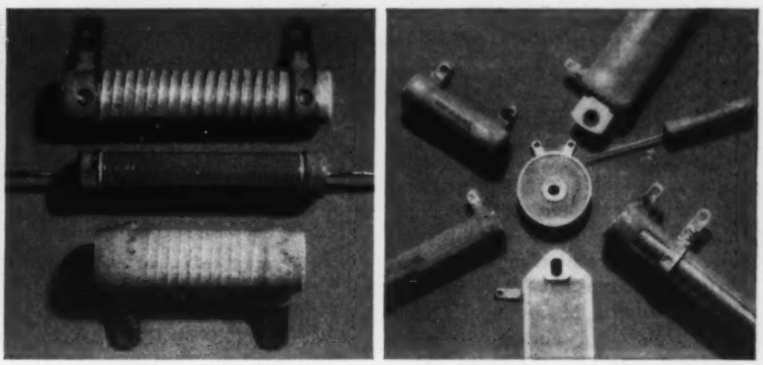


finest alloy resistance wire



spot welded or silver brazed junctions

THIS IS A RESISTOR YOU CAN STAKE YOUR REPUTATION ON



our own VITROHM enamel, first coat . . . and final coat

Built-in VITROHM reliability, from core to final vitreous enamel, lets you solder these resistors in and forget 'em

They come in a tremendous variety of sizes, shapes and ratings, but all Ward Leonard VITROHM resistors have one thing in common: They're built for maximum reliability.

Take just one point—ceramic cores, for example: Made by Ward Leonard to exacting specs, the cores feature low-porosity, high-dielectric-strength ceramic for maximum moisture exclusion and good electrical insulation. What's more, the thermal coefficient of linear expansion of ceramic is specially selected to make the core compatible with resistance wire, enamel and terminals . . . to prevent cracking, crazing, peeling, or layer separation.

And there's the same meticulous care with all the other elements that go to make up a finished VITROHM resistor: terminals, spot welded or brazed junctions, resistance wire, and last but not least, W/L VITROHM enamel, formulated and manufactured in our own modern enamel smelting plant . . . provides complete electrical and mechanical protection.

To insure reliability in your product . . . specify VITROHM's. Write for data packed catalog #15, and list of stocking Electronic Distributors: Ward Leonard Electric Co., 58 South Street, Mount Vernon, N.Y. (In Canada: Ward Leonard of Canada Ltd., Toronto.) 9.4

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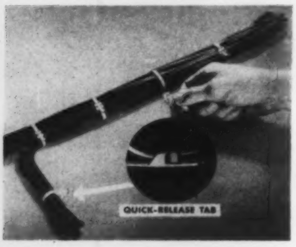
New Parts and Materials

Use Yellow Card, page 19, to obtain more information

Cable Clamps

nylon units are fully adjustable

Lok-Strap nylon cable clamps incorporate a miniature, quick-release tab which holds band of clamp securely and tightly around wires. It opens instantly with a few ounces of fingertip pressure. Tab also allows almost infinite adjustment of clamp or tie to accommodate wire harnesses from $\frac{1}{8}$ to 2 in. diam. Clamps can be opened, closed, and readjusted repeatedly without damage and without special tools. Of all-nylon, precision-molded construction, clamps have excellent electrical insulating characteristics, high tensile strength, and service temperature range from −65 to 350 F. **Panduit Corp.**, Dept. MDC, 14461 Waverly Ave., Midlothian, Ill. I

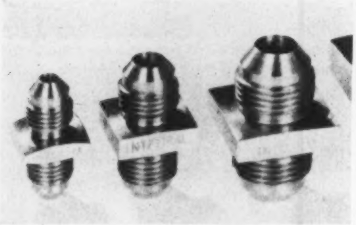


Circle 759 on Page 19

Miniature Check Valves

for temperatures to 700 F

Miniaturized check valves are suitable for low-pressure-drop, high-pressure requirements. The lightweight units, furnished in aluminum, stainless steel, brass, or titanium, can be incorporated in AN or MS-type fittings, including elbows, reducers, and tees. Sharp-edged, nonflowing plastic material is used as a washer which is inserted in valve poppet and seals against conical seat. Valves are applicable to hydraulic, pneumatic, and fuel systems operating within temperature range of −65 to 700 F and operating pressures to 5000 psi. Same valves, with other sealing material, are suitable for use with missile acid, and LOX systems at operating temperatures from −320 to 700 F and operating pressures to 3000 psi. **Integral Corp.**, 100 Frank Rd., Hicksville, L. I., N. Y. D



Circle 760 on Page 19

Soft Neoprene Compound

has excellent tensile strength and elongation

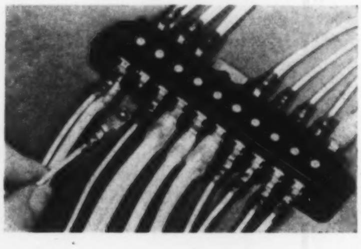
Three neoprene compounds have durometers of 7, 11, and 15. Tensile strengths are 510, 853, and 1200 psi, and elongations are 800, 723, and 650 per cent, respectively. Oil, weather, and resistance characteristics of neoprene are maintained. **Mechanical Rubber Products Co.**, 1 Gallagher Rd., Warwick, N. Y. D

Circle 761 on Page 19

Terminal Block

for use in flat spaces

T-1010 terminal block permits side entry, which allows installation in flat, crowded spaces in which a vertical-entry block cannot be used. Block is constructed of molded phenolic base with reinforced barriers between numbered, easily read terminal cavities. One cavity accommodates four terminals, and up to 40 connections can be made with one block. Block is 5 in. long, $1\frac{1}{4}$ in. wide, 11/16 in. high. Lug is inserted in block and setscrew is tightened. Once connection is made and screw is tightened, over 100 lb pressure is required to break it. **Twin Lock Inc.**, 1024 W. Hillcrest Blvd., Inglewood, Calif. L

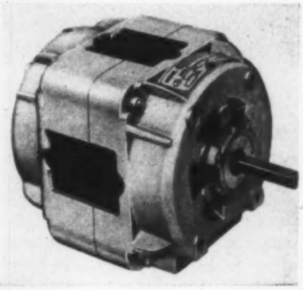


Circle 762 on Page 19

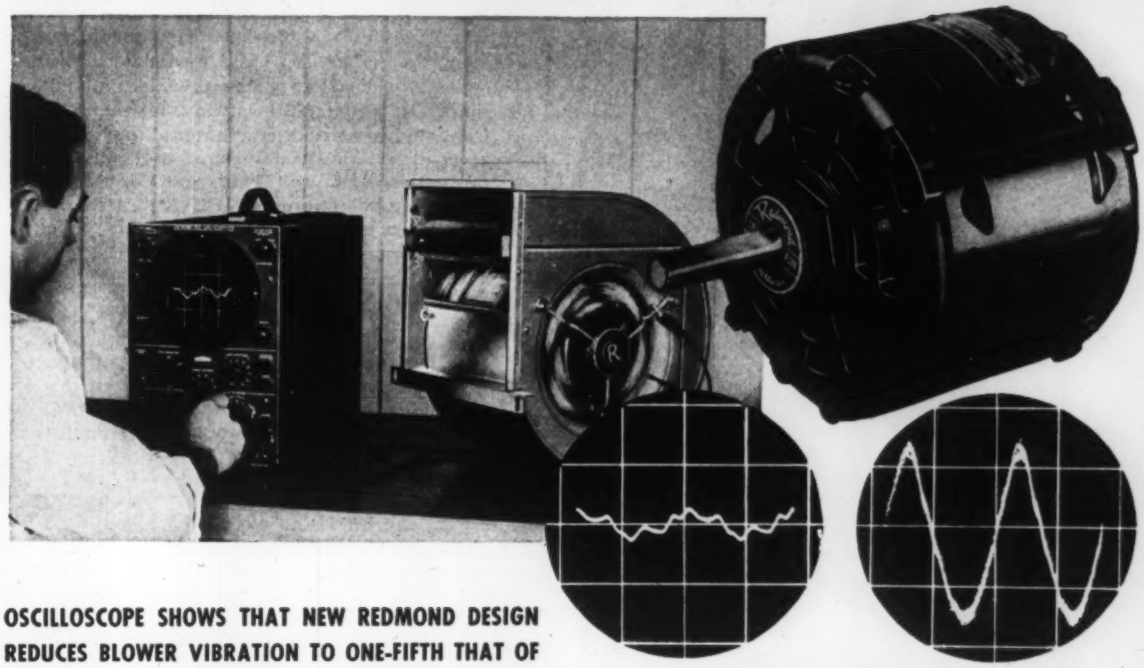
Induction Motor

miniature unit provides minimum cogging and hunting

Model 9200 miniaturized induction motor is for use in tape recorders, communication equipment, office machines, turntables, movie projectors, aircraft, instruments, and electronic devices. It features especially designed magnetic and electric circuits, and sinusoidally distributed windings and internal rotor slotting. Unit has quiet operation, low-level magnetic hum, reduced external magnetic field, low temperature rise, and minimum cogging and hunting. Frame size is $2\frac{7}{8}$ x $2\frac{7}{8}$ in. with over-all length of 4 1/32 in. for frame 9210 and



New *Redmond* Motor Is Quietest For Direct Drive Blowers



These photographs of the oscilloscope screen show the reduction of vibration in the blower when the Redmond Type AY MicroMotor is used. The photo at the left shows blower vibration with the Redmond AY; the one at the right shows vibration with a competitive motor.

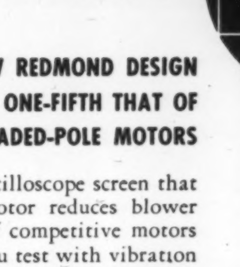
OSCILLOSCOPE SHOWS THAT NEW REDMOND DESIGN REDUCES BLOWER VIBRATION TO ONE-FIFTH THAT OF UNITS USING CONVENTIONAL SHADED-POLE MOTORS

You can see for yourself on the oscilloscope screen that the Redmond Type AY MicroMotor reduces blower vibration to only one-fifth that of competitive motors running in the blower. Whether you test with vibration testing equipment, a mechanic's stethoscope, or an oscilloscope, you will conclude that the AY is the quietest direct-drive blower motor available. Use it to solve the problem of vibration in your blowers.

The AY Tri-Flux motor is designed and manufactured in every way to give years of trouble-free service and whisper-quiet operation. The Tri-Flux design adds a third flux path, making possible a larger diameter shaded-pole motor that is more efficient and has higher starting and running torque than conventional shaded-pole motors. The positive oil system provides force-feed lubrication. Recirculating the oil assures maximum bearing life.

The new AY is ideal for a wide variety of applications requiring a quiet, economical, quality motor. Redmond sales engineers are skilled technicians whose primary function is applying a motor to your product. Contact us at Owosso, Michigan, and we will have the Redmond sales engineer in your district call you at once. See your telephone book for locations of sales offices in Cincinnati; Cleveland, Dallas; Newark; El Segundo, California; and Oak Park, Illinois.

NEW CATALOG ▶



New 12-page catalog describes and illustrates basic line of Redmond fractional horsepower electric motors, blowers, and special products. Send request for your free copy to Redmond Company, Inc., Owosso, Michigan.

The Standard of Dependability

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Subsidiary of CONTROLS COMPANY of AMERICA
OWOSSO, MICHIGAN
THE BIG NAME IN SMALL MOTORS
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Circle 533 on Page 19

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The "Custom" approach, already made famous by IPC oil seals and packings is *also* reflected when IPC tackles unusual molded shapes. If you require an unusual molding from rubber or synthetic material, *or* if you need a seal of special shape and specific properties, IPC *can* help you. By using the "custom" approach IPC will actually develop a tailored product to suit your application.

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Bristol, New Hampshire

P3

Circle 534 on Page 19

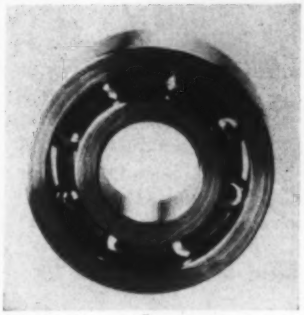
4 13/32 in. for frame 9214. Motor is a permanent split-capacitor, single-phase, 50/60-cycle unit available in induction, torque, and synchronous types. It is also available in two or three-phase designs. Horsepower ratings are from 1/300 to 1/30 hp. Motor allows six different types of mounting. **Howard Industries Inc.**, 1760 State St., Racine, Wis. K

Circle 763 on Page 19

Radial Bearings

for applications to 900 F

Deep-groove radial bearings are available in three R-series sizes: R-2, bore, 0.125 in., OD, 0.375 in.; R-3, bore, 0.1875 in., OD, 0.5 in.; R-4, bore, 0.25 in., OD, 0.625 in. Bearings, for use in applications to 900 F, are manufactured to ABEC-5 tolerances. Material for balls, races, and retainers is high-speed tool steel. Retainers are machined, and of snap-in construction. **Industrial Tectonics Inc.**, 3686 Jackson Rd., Ann Arbor, Mich. H

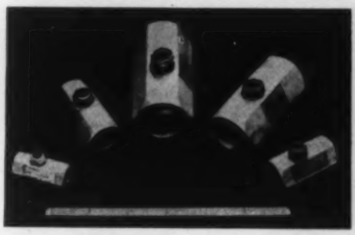


Circle 764 on Page 19

Speed-Control Valve

withstands pressures to 2000 psi

Vairi-Speed valve is a combination needle and ball-check unit. It controls speed of a single or double-acting air or hydraulic cylinder by restricting flow from exhaust end of cylinder during piston movement in one direction. Movement in opposite direction unseats ball check and bypasses needle-valve section. Valve controls only fluid volume and has no effect on incoming pressure or cylinder-output force. Controlled flow, with ball check seated, is directed from large end of needle valve to small end. Large-diameter needle and direction of fluid flow provide nonturbulent flow which is largely unaffected by contaminants. Aluminum valve bodies withstand pressures to 2000 psi. All other parts are stainless steel. Valve is available for pipe sizes from 1/8 to 3/4 in. **Control Line Equipment**, 19560 Center Ridge Rd., Cleveland 16, Ohio. G



Circle 765 on Page 19

Gearhead Motors

are available in gear reductions to 8000:1

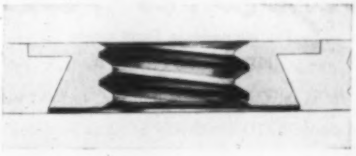
Size 10 and 11 gearhead hysteresis synchronous motors are available for 26, 55, or 120-v ac 400-cycle operation. Other voltages are available on special order. Motors, which are 2 17/64 in. long, are supplied in any gear reduction up to 8000:1. They are designed for operation in ambient temperatures from −65 to 125 C. **Electro Products Div., Western Gear Corp.**, 132 W. Colorado St., Pasadena, Calif. L

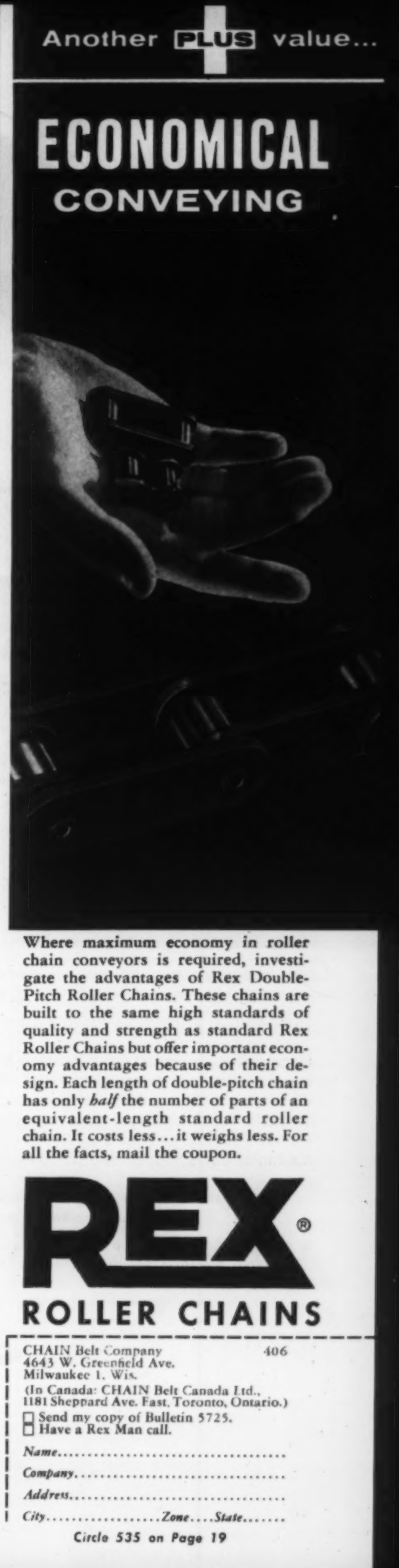
Circle 766 on Page 19

Flush-Thread Inserts

for thin metal sheets

PEM self-clinching fastener provides a flush mounting area on both sides of sheet in which it is applied. Dropped into drilled or punched holes, fastener is easily applied with pneumatic or oil-hydraulic squeezer or mechanical press. Metal displaced by the head flows around back-tapered shank, securely locking fastener into sheet with high push-out resistance. Hex shape of embedded head also provides high torque resistance. Made in 303 stainless steel with thread sizes from





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Where maximum economy in roller chain conveyors is required, investigate the advantages of Rex Double-Pitch Roller Chains. These chains are built to the same high standards of quality and strength as standard Rex Roller Chains but offer important economy advantages because of their design. Each length of double-pitch chain has only *half* the number of parts of an equivalent-length standard roller chain. It costs less... it weighs less. For all the facts, mail the coupon.

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Circle 535 on Page 19

"Dad believes in good guns and good gun manners"

"He just bought me a new gas-powered Hahn BB rifle. It's real sharp and shoots straight, but he won't let me use it alone until I've learned good gun manners."

Hahn BB guns, styled after famous lever-action Western frontier rifles, have the look and feel of Dad's guns—and they shoot straight. This is due to the accuracy of the barrels. They are made from commercial grade Superior carbon steel tubing —known for the consistent uniformity of its ID finish, free machining characteristics and economy.

Examples of other unusual applications of this Superior tubing

- Carbon steel rectangular tubing for collimating tubes in a research reactor (.900 in. x .400 in. ID x .025 in. wall in 10-ft. cuts)
- Specially conditioned ID tubing in long lengths used as high pressure diesel lines on earthmoving equipment (¼ in. OD x .088 in. ID)
- Cadmium plated compression sleeves for connecting the steel core of ACSR high tension cable (.404 in. OD x .179 in. ID in 5-in. cuts)
- 2½ million ft. of carbon steel tubing in random lengths for the gear pinion in the timing fuse of artillery shells (.204 in. OD x .067 in. ID)

Filling tubing orders that range from a few feet to millions, in a wide variety of materials, shapes and sizes, calls for the resources Superior has to offer. Why not investigate the advantages of using us as a source of tubing. Bulletin 41, a guide to the selection and application of Superior tubing, is yours for the asking. Write Superior Tube Company, 2010 Germantown Ave., Norristown, Pa.

Superior Tube
The big name in small tubing
NORRISTOWN, PA.

All analyses .010 in. to ⅝ in. OD—certain analyses in light walls up to 2½ in. OD

West Coast: Pacific Tube Company, 5710 Smithway St., Los Angeles 22, Calif. • RAymond 3-1331

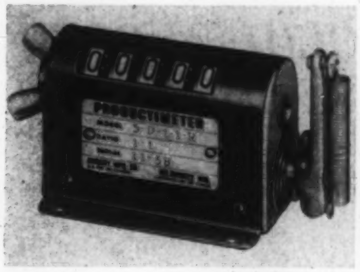
Circle 536 on Page 19

No. 2-56 to 10-32, it is suitable for use in aluminum alloys, brass, copper, cold-rolled steel, and similar sheet materials in thicknesses from 0.061 in. up. **Penn Engineering & Mfg. Co.**, Doylestown, Pa. F

Circle 767 on Page 19

Light-Duty Counters

for high-speed applications



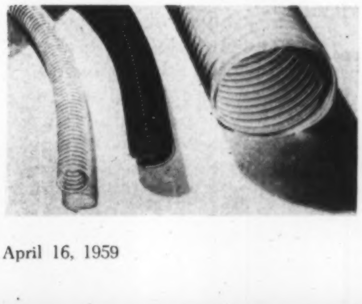
Series D stroke and rotary counters are designed for high-speed, light-duty application. They are available in both spur-gear end-drive or right-angle worm-drive designs. Stainless-steel drive shafts, pinion shafts, and reset shafts have been incorporated into all models. **Durant Mfg. Co.**, 1933 N. Buffum St., Milwaukee 1, Wis. K

Circle 768 on Page 19

Plastic Hose

is wire-coil reinforced

Dayflex wire-coil reinforced plastic hose can be used for low-presure air-moving applications as in home dryers, defrosters, exhaust systems, suction feeders, and as damping devices on controls. Hose, especially useful for venting moisture-laden air or fumes at temperatures to 180 F, is nonporous, resistant to airborne abrasive particles, and inert to most chemicals. It consists of a tough PVC skin, supported by a PVC-covered spring-steel coil. It is currently available in diameters to 4 in. and can be produced to meet special strength and flexibility requirements. Wire prevents hose from collapsing, while increasing its flexibility. Hose is available in a wide range of colors, transparent, translucent, or opaque, with high surface luster. **Dayflex Hose Div., Dayton Rubber Co.**, Dayton 1, Ohio. G

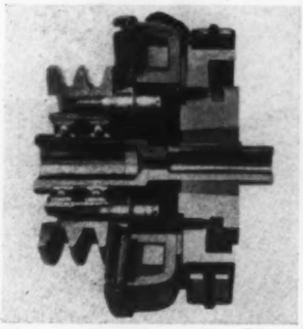


Circle 769 on Page 19

Clutch and Sheave Assembly

electric unit engages or releases at any speed

Electro-Sheave combined electric clutch and sheave assembly is for direct installation on all standard NEMA electric-motor shafts. Five sizes of standard clutch units are rated from 1 to 25 hp. Unit engages or releases at any speed. For inching or jogging, several starts are possible in less than one revolution of clutch. Release is instantaneous and load is braked without plugging motor. Clutch, ball-bearing sheave, and shaft-extension sleeve all fit as a single package onto standard NEMA motor shafts. Because motor runs continuously when used with assembly, inertia of motor rotor and clutch magnet aids motor. Breakdown torque of motor is available for starting load, permitting a smaller motor to be used in many applications. **Warner Electric Brake & Clutch Co.**, Beloit, Wis. K



Circle 770 on Page 19

Flexible Rubber Impellers

have long service life in self-priming pumps

Flexible impellers provide high tensile strength and excellent resistance to oxidation, compression set, abrasion, and tearing. Compounds of neoprene and Hycar handle a vari-

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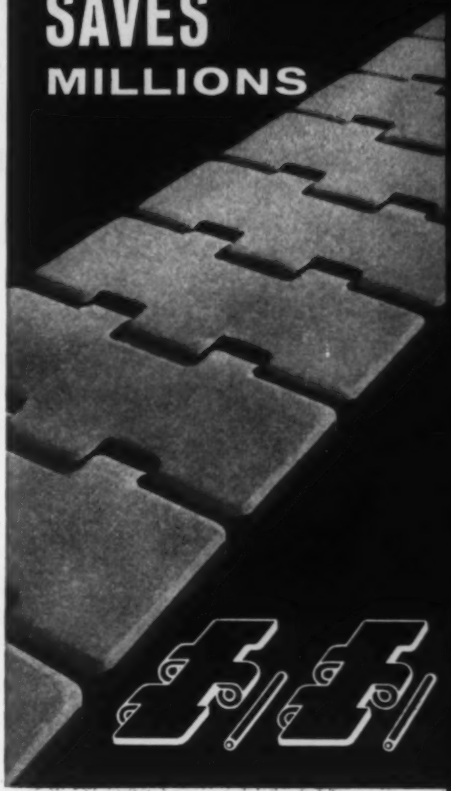

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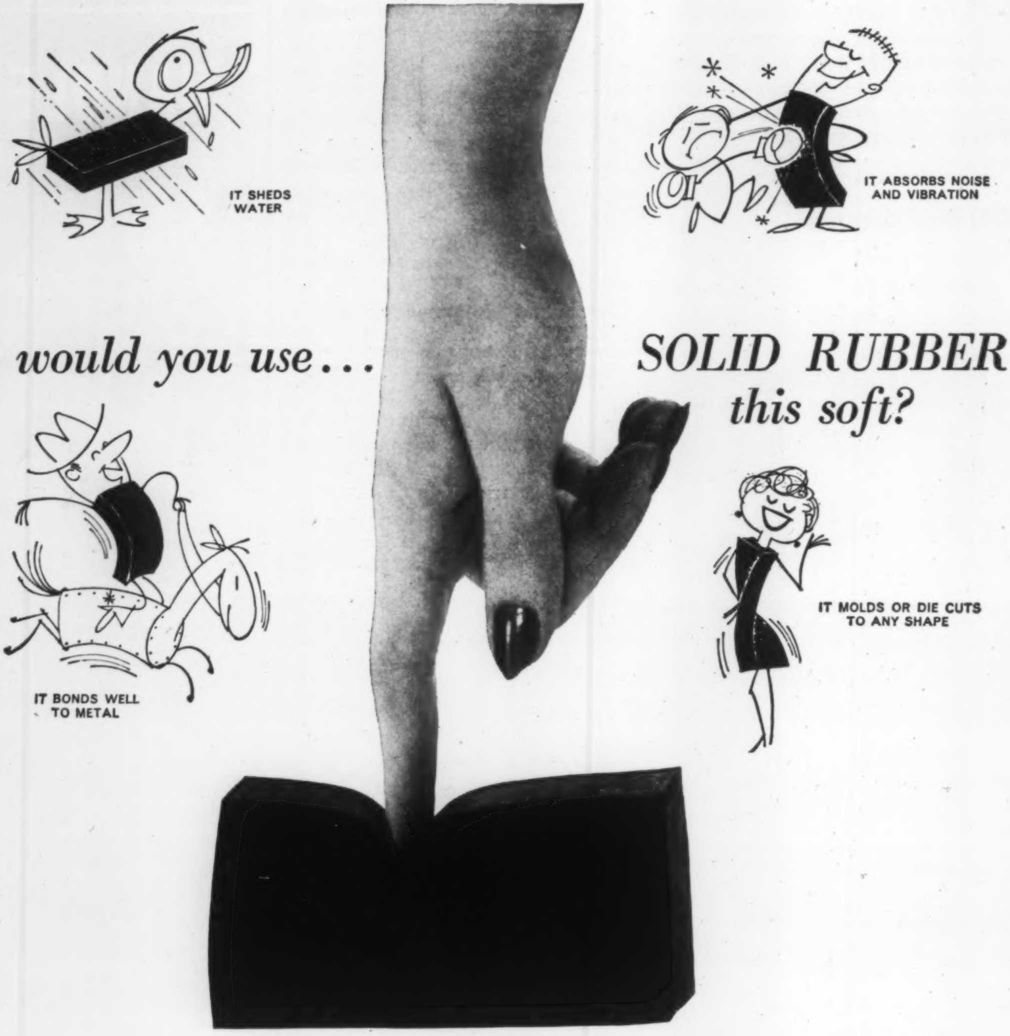
Circle 537 on Page 19


IT SHEDS WATER
IT ABSORBS NOISE AND VIBRATION
How would you use... SOLID RUBBER this soft?
IT BONDS WELL TO METAL
IT MOLDS OR DIE CUTS TO ANY SHAPE

To help you decide, send for the booklet "How Designers Are Using The Softest Solid Rubber Available"—A hearing aid manufacturer uses Roth Super-Soft in grommets half the diameter of your cigarette—to absorb barely perceptible vibrations. A maker of flexible steel conveyor belts says it provides the tough, watertight, airtight seal he needs. Between these extremes we know there must be a galaxy of other uses. Perhaps you have thought of some already. Roth Super-Soft is a non-porous neoprene base rubber. It is actually softer than some sponge rubber . . . can be molded and die cut . . . bonded by cementing or vulcanization. Consider the possibilities —then write for our booklet that illustrates some uses and gives full information on properties and specifications.

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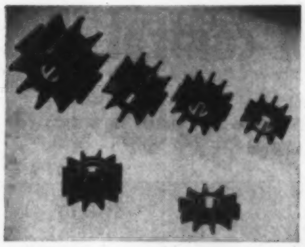
Circle 538 on Page 19



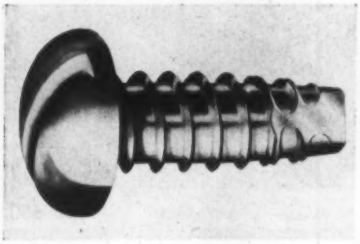
ety of liquids at temperatures from 40 to 175 F. Impellers, designed for self-priming pumps, are available in standard or special sizes suitable for pumping capacities from ½ to 120 gpm, and operate at speeds from 300 through 6000 rpm. **Special Products Div., Pacific Moulded Products Co.,** 905 E. 59th St., Los Angeles 1, Calif. L

Circle 771 on Page 19

Thread-Cutting Screw

for use in nylon

Type L screw functions as a combination thread-cutting and thread-forming screw. For use in nylon, it cuts a small amount of the nylon to allow full diameter threads to form. Screw is of particular advantage in nylon assemblies which must be disassembled for service, since it can be removed and replaced without stripping or galling. **Parker-Kalon Div., General American Transportation Co.,** Clifton, N. J. D



Circle 772 on Page 19

Silicon Bridge Rectifiers

subminiature units are for temperatures to 165 C

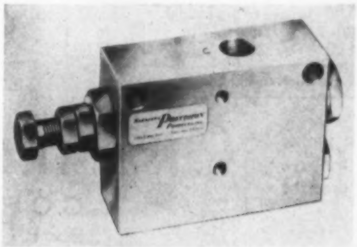
Series of silicon bridge rectifiers replaces vacuum-tube units in one-fiftieth of the volume, and weigh less than one one-hundredth of equivalent tube circuitry. Devices are designed to provide extreme miniaturization in missile, airborne, and ground-system circuitry, and can be operated at temperatures to 165 C. Wide flexibility of design and voltage ratings is possible in a single package size, since units are mounted assemblies of miniature silicon diodes. Rectifiers are available with ratings from 50 to 500 piv, with dc output currents up to 0.8 amp. Units are equipped with threaded mounting bosses for easy circuit installation. Other circuit configurations, including half-wave, center-tap, and doubler rectifiers, are available on request. **International Rectifier Corp.,** 1521 E. Grand Ave., El Segundo, Calif. L

Circle 773 on Page 19

Holding Valve

for hydraulic-circuit use with pressures to 3000 psi

Holding valve for use in hydraulic circuits locks cylinder or motor when no motion is desired. It prevents load from running ahead of oil supply when load is being moved, and relieves excessive pressures generated in cylinder by load. In case of power failure it permits load to be lowered manually. Valve uses little or no power when load is elevated and nominal amount of power when it is lowered. Valve locks cylinder and opens with pilot-pressure assist of approximately 20 per cent of difference between load-induced pressure and valve setting. Single models with external pilot and port, for use with single-acting cylinder or for mounting at both ends of a double-acting cylinder, are available with dryseal ⅜-in.



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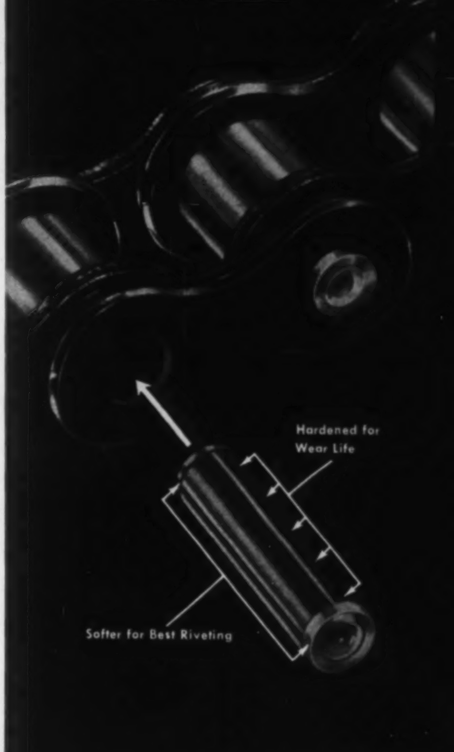

The famous Rex Copper-Plated Pins are one of the important *PLUS VALUES* you get in Rex Roller Chains.

The softer copper-plated pin ends assure maximum holding power in the link plates and, at the same time, permit the chain to be uncoupled easily. The bushing is not displaced when the pin is removed . . . no loss of chain life. Hardened pin body provides long wear life. For the story, mail the coupon.

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Circle 539 on Page 19

Cycling timers offer reliable program control in simple or complex applications . . . .

FIXED CYCLE, FIXED SWITCH-TRANSFER POINTS.

Timers of this type provide the simplest form of repetitive switching control, at very modest cost. They are commonly built in as part of the equipment to be controlled, and have no external controls or indicators. The total cycle time is fixed according to the requirements of the user, as are also the timed points at which switch transfer occurs. An example is the Cramer Type 571.

FIXED CYCLE, ADJUSTABLE SWITCH-TRANSFER POINTS.

In this type of control, the total cycle time is fixed to the user's specifications, but the points at which switch transfer occurs can be easily changed. This flexibility makes such timers ideal where the timing program must occasionally be modified, within the same basic cycle period. Examples of such controls are Cramer Types 511, 521, and 610.

ADJUSTABLE CYCLE, FIXED SWITCH-TRANSFER POINTS.

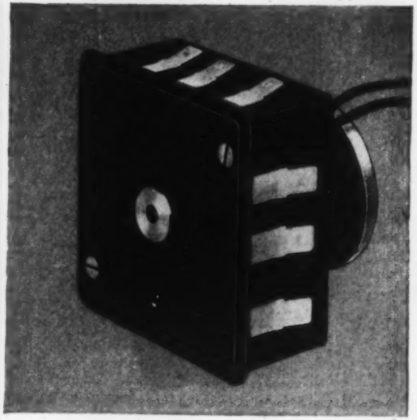
Here, the cycle length as a whole is adjustable by the user, but the interval within that cycle represented by the ON and OFF switch transfer actions remains fixed to initial specifications. Such a timer is necessary where the frequency rate of some repeated process is subject to change, but the controlled interval within each cycle must be constant. An example of this kind of timer is the Cramer Type 650.

ADJUSTABLE CYCLE, ADJUSTABLE SWITCH-TRANSFER POINTS.

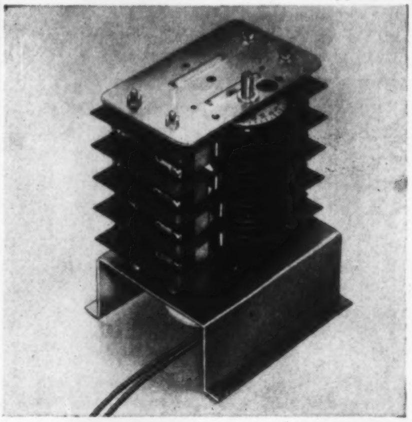
Occasionally, it is desirable to be able to change both the total cycle and the length of the controlled interval within the cycle. A timer which permits this is the Cramer Type 742, in which two adjustable-cycle timers are connected in series so that each in turn is actuated by the other. By adjusting their cycle periods independently, an endless number of combinations of cycle length and ON-OFF period may be obtained.

These timer types indicate the breadth of Cramer's cycle timer line for industrial applications. Military applications require many additional features such as hermetic sealing, extreme precision, resistance to shock and to vibration and the ability to operate reliably under stringent environmental conditions. Cramer's complete line contains outstanding units designed to meet military specifications.

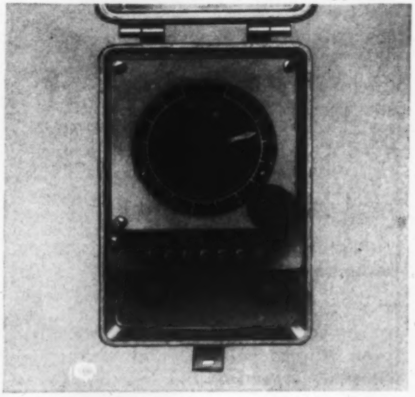
Type 571



Type 521



Type 650



CRAMER TYPE NUMBER	571	511	521	610	650	742
Time Ranges	60 s to 8 d	6 s to 48 h	6 s to 48 h	15 s to 24 h	15 s to 24 h	6 s to 24 h
Load Switches	1 to 4	1 to 3	4 to 8	1	1	2
Load Switch Rating	30 amp. 115v ac	20 amp. 125v ac	20 amp. 125v ac	10 amp. 125v ac	10 amp. 125v ac	15 amp. 125v ac
Repeat Accuracy (% of total range)	1½%	½%	½%	1%	1%	¼%
Adjustable Cycle	No	No	No	No	Yes	Yes
Adjustable Switch Transfer	No	Yes	Yes	Yes	No	Yes
Mounting	Surface	Surface	Surface	Panel	Surface or Housing	Panel or Housing
Unit List Price	$8.50 to $11.50	$16.00 to $24.00	$28.00 to $44.00	$27.00	$50.00 to $56.00	$84.00 to $107.00
Ratings	All standard voltages in 50, 60 and 400 cps AC, and in DC					

LEARN MORE about these and other basic timing devices from Cramer's complete line. Write for free bulletins on the types that interest you . . . or describe your problem and let us help you solve it.

CRAMER CONTROLS
CORPORATION
Box 6, Centerbrook, Connecticut

Circle 540 on Page 19

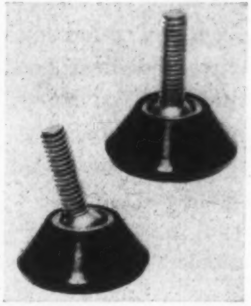
NPTF ports, or for gasket mounting on cylinder heads. Double models with internal pilots are also available. Both units are for 3000-psi service. **Sarasota Precision Products Inc.**, 1314 N. Lime Ave., Sarasota, Fla. O

Circle 774 on Page 19

Leveling Glide

has swivel base

Designed to provide firm support for slanted legs on sloping or uneven floors, swivel-stemmed glide has a rugged phenolic base. It is suited for use on all types of furniture, appliances, or any equipment that demands leveling for best use. Ball and socket arrangement makes it easy to level any piece of equipment or appliance by turning base of glide fingers. Glide fits standard threaded furniture sockets, T-nuts, and weld-on nuts, or can be attached directly to metal equipment. **R. F. Winans Co. Inc.**, P. O. Box 525, Doylestown, Pa. E



Circle 775 on Page 19

Self-Locking Nut

has 150,000-psi tensile strength at 900 F

FN920 lightweight, high-strength, self-locking nut is for use at elevated temperatures to 900 F. It has tensile strength of 200,000 psi at room temperature and 150,000 psi at 900 F. Nut, forged from aircraft quality AMS 6304 alloy steel, is available with either silver or diffused nickel-cadmium, high-temperature plating for corrosion and oxidation resistance. Both finishes can be supplied with or without dry-film lubricant. Nut is made in diameter sizes No. 10 through $\frac{3}{8}$ in. It meets squareness requirements of MIL-N-7873. Threads are Class 3B fit and meet military specification MIL-S-7742. Twelve-point external wrenching drive permits tightening to induce high loads needed to maintain fatigue resistance. **Standard Pressed Steel Co.**, Jenkintown, Pa. C

Circle 776 on Page 19

Straw-Colored Plastic

has high heat resistance

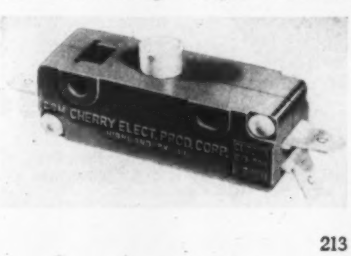
PL-12 acrylic-type thermoplastic polymer has heat distortion point of 240 F, flexural modulus of 415,000 psi, and notched izod impact strength of 1 lb-ft per in. Injection molding and extrusion can be carried out by conventional acrylic techniques. Natural resin is straw colored and has fair transparency. Molding powder is available in limited quantities for evaluation. Interest has been shown for use as an engineering material—for housings, fasteners, handles, gears, and consumer items such as safety equipment, radios, pens, and sporting goods. **J. T. Baker Chemical Co.**, Phillipsburg, N. J. D

Circle 777 on Page 19

Appliance Switch

is rated $1\frac{1}{2}$ hp at 250 v ac

E13-00A switch offers long life cycle and accurate repeatability. It features 0.1 in. overtravel and $1\frac{1}{2}$ hp rating at 250 v ac for appliance and automatic device applications. Case has interlocking design, standard



Another PLUS value...

EASY TO COUPLE AND UNCOUPLE

Here's a tremendous *PLUS VALUE* for users of multiple-strand roller chains ...Rex Glide-Fit! This chain can be taken apart easily at any link in the strand; yet, properly applied and lubricated, it has a wear and fatigue life equal to drive-fit roller chains. Pins are a drive-fit in the outer link plates only ...a *glide-fit* through the inner link plates. It cuts "down time" to the minimum...saves time and money. For all the facts, mail the coupon.

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Circle 541 on Page 19

"I know my product does better than this… but how can I prove it?"

Yes, your customers are *always* right . . . *when there's no proof to the contrary*. But when you can prove *on the record* that performance is up to guarantee, then there's no further argument. And you can give them that record by building into your product a Veeder-Root Counter as a standard, integral part . . . to count in any terms or units your customers could want. This is easy to do . . . and inexpensive, too. Let us figure it out for you. Write.

You always "Know the score" when you count on Veeder-Root!

VEEDER-ROOT
77201

NEW
High Speed, Quick Reset REVOLUTION COUNTER

This is one of scores of types of counters made by Veeder-Root for manual, mechanical and electrical counting. This counter runs at speeds up to 6,000 rpm . . . resets to zero with one flick of the lever. Also available with predetermining feature.

Everyone can Count on VR ®

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Hartford 2, Connecticut
Hartford, Conn. • Greenville, S. C. • Altoona, Pa. • Chicago
New York • Los Angeles • San Francisco • Montreal
Offices and Agents in Principal Cities

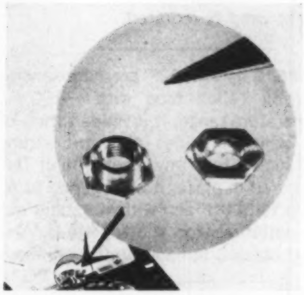
mounting dimensions, and is environment-resistant. Wear-resistant nylon button provides smooth operation with or without actuators. Actuators include roller leaf, leaf, pushbutton, and overtravel pushbutton. Switch accepts both snap-in actuators and actuators secured by mounting screws. Chamfered hole in terminal permits use of either solder or standard quick-connect terminal wiring. **Cherry Electrical Products Corp.,** 1650 Deerfield Rd., Highland Park, Ill. I

Circle 778 on Page 19

Miniature Brass Nuts

for precision instruments

Miniature brass turned nuts are furnished in a range of types, shapes, and sizes for use in precision instruments and miniaturized equipment. They are supplied to individual specifications with standard or special threads in diameters as small as 1/8 in. hexagon. Nuts are tapped square with faces, countersunk on both sides, burrless, degreased, and can be furnished in either single or double-chamfered styles and special shapes. Lengths and diameters are held to +0.000 and −0.005 in. **Fischer Special Mfg. Co.,** 451 Morgan Ave., Cincinnati 6, Ohio. G

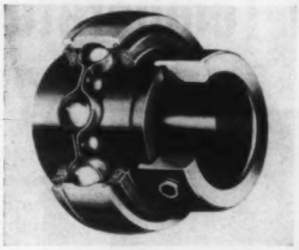


Circle 779 on Page 19

Bearing Units

have eccentric-collar shaft locks

Machine unit ball bearings are equipped with either spherical seat for automatic self-alignment (shown) or with straight ODs for more rigid, accurate shaft location. Units are designed for easy adaptation to all types of housings requiring self-contained ball bearings. Collar, which secures unit to shaft, is a self-tightening, eccentric type that provides easy and positive locking upon installation. Bearings are furnished either sealed for life or with lubricant channels in outer bearing to provide for relubrication. Bearing units are available in 32 shaft sizes from 3/4 to 2 15/16 in. **Hoover Ball & Bearing Co.,** 5400 S. State Rd., Ann Arbor, Mich. H



Circle 780 on Page 19

Wire Alloys

nickel-silver alloys have good cold-working properties

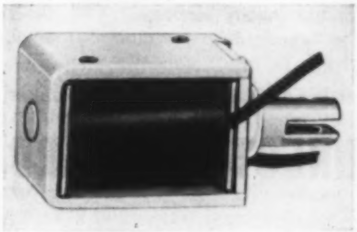
Two nickel-silver wire alloys have uses such as in screws and rivets, slide fasteners, cameras, optical parts, and costume jewelry. Alloys have 18 per cent or 12 per cent nickel silver and have excellent cold-working properties. They are readily formed, bent, or cold headed and can be joined by soft soldering, silver-alloy brazing, resistance, or oxyacetylene welding. **Bridgeport Brass Co.,** 30 Grand St., Bridgeport 2, Conn. B

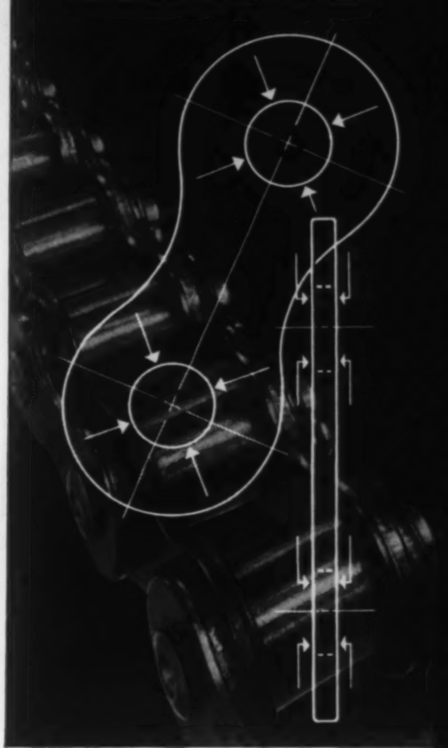
Circle 781 on Page 19

Miniature Solenoid

dc unit is for continuous or intermittent uses

No. 22 solenoid combines maximum power capacity with extremely small size for efficient performance in miniaturized assemblies. Plunger strokes are adjustable from 1/32 to 5/16 in. with maximum lift of 11 oz for continuous duty, and 24 oz for intermittent duty. Over-all dimensions





Another PLUS value...

FIGHTS FATIGUE

To fight fatigue, link plate holes in Rex Roller Chains are accurately located in relation to each other...accurate in size throughout the thickness of the link...parallel...smooth and uniform. This accuracy assures exceptionally close control of chain pitch. Pitch control means extra resistance to fatigue...longest chain life. For the complete story on the *PLUS VALUES* in Rex Roller Chain, mail the coupon.

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☐ Send my copy of Bulletin 5725.
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Company..............................
Address..............................
City..................*Zone*....*State*.......

Circle 543 on Page 19

Now 4 CHR High Temperature TEFLON® Tapes

Pressure-Sensitive TEFLON Tapes

easy to apply in both electrical and mechanical applications

The electrical uses of Temp-R-Tape include slot lining, interlayer and interphase insulation, harness bundling, wrapping for microwave components, transformer coils, capacitors and high voltage cables, etc.

As a low friction, non-stick facing, Temp-R-Tape applications range from facings for film guides in sensitive electronic instruments to the facing for heat sealing bars, forming dies, chutes, guide rails, etc.

Chemical resistant facing applications include masking tape in high temperature dipping operations.

All four of these pressure-sensitive Teflon tapes are available from stock in rolls and in sheet form. In addition to Teflon tapes, CHR also makes a fiberglass tape with thermal curing, pressure-sensitive silicone adhesive (Temp-R-Tape GV) and silicone rubber coated fiberglass tape with thermal curing, pressure-sensitive silicone adhesive (Temp-R-Tape SGV).

FREE SAMPLES and folder — write, phone or use inquiry service.

— −100°F to 500°F applications

— Class H and Class C insulation

— Non-stick and low friction facing

— Chemical resistant facing

TEMP-R-TAPE T is a .006″ pressure-sensitive Teflon tape with −100°F to 400°F (−70°C to 200°C) temperature range. It has high dielectric strength, low power factor, negligible moisture absorption, high elongation, is non-corrosive and non-contaminating. Meets Class H Temperature requirements.

TEMP-R-TAPE TH is a .013″ pressure-sensitive Teflon tape with −100°F to 400°F temperature range. It is similar to Temp-R-Tape T except that it is made of .010″ Teflon film to which .003″ silicone polymer adhesive has been added. Often used where a single, thicker dielectric barrier is desired or where a more rigid, abrasion resistant wrap is required.

TEMP-R-TAPE C is a .002″ pressure-sensitive, thermal curing Teflon tape with −100°F to 500°F temperature range. It is made with a cast Teflon film which provides dielectric strength (2750 v/m) higher than any other type of Teflon film. When cured in place, it will operate at temperatures up to 500°F and will withstand much higher temperatures for short periods. Meets Class H and Class C temperature requirements.

TEMP-R-TAPE TGV is a thermal curing, pressure-sensitive Teflon impregnated fiberglass tape with −100°F to 500°F temperature range. Although it is used extensively for mechanical and electrical applications, its dielectric strength is lower than other Temp-R-Tapes.

CHR products include:

COHRlastic Aircraft Products — *Airframe and engine seals, firewall seals, coated fabrics and ducts*

COHRlastic Silicone Rubber Products — *Silicone rubber moldings and extrusions, silicone rubber sheets, silicone sponge rubber*

Temp-R-Tapes — *Pressure sensitive, thermal curing Teflon and silicone tapes*

Allied Products — *COHRlastic silicone cements and conductive gasketing*

CHR Leader In Fabrication of Silicone Rubber

CONNECTICUT HARD RUBBER COMPANY

Main Office: New Haven 9, Connecticut

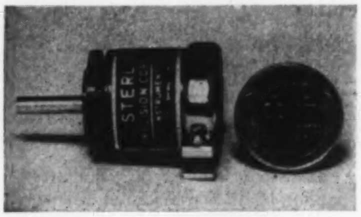
Circle 544 on Page 19

are ¾ in. high, 1⅛ in. long, and ¾ in. wide. Coil ratings range from 6 to 110 v dc. **Guardian Electric Mfg. Co.,** 1621 W. Walnut St., Chicago 12, Ill. J

Circle 782 on Page 19

Modular Gearhead

is available in any ratio up to 175:1



T612 modular gearhead is designed for use in high-accuracy computers, servo systems, and other precision devices. It is available in any desired ratio up to 175:1. **Instrument Div., Sterling Precision Corp.,** 17 Matinecock Ave., Port Washington, N. Y. D

Circle 783 on Page 19

Control Valve

in ½-in. pipe size

Valve is designated for use on air compressors that unload to atmosphere, and for other applications requiring a controlled movement of air. It has a machined aluminum body with brass piston and shaft assembly. Valve is furnished in ½-in. pipe size with ⅛-in. activating and discharge ports. **Keisling-Stanley Co.,** Boylston, Mass. B

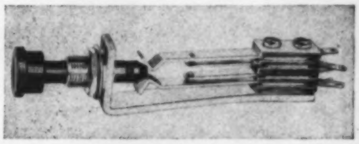
KS
KEISLING

Circle 784 on Page 19

Pushbutton Switch

is locking-type unit

Designed to save panel space, locking-type pushbutton switch mounts easily on ⅝-in. center. It is constructed with plated steel frame and has contact leaf of nickel silver and contacts of fine silver. Fingertip pushbutton is molded plastic. Unit is available in standard 3-amp rating in a wide variety of circuits. **Richards Electrocraft Inc.,** 4432 N. Kedzie Ave., Chicago, Ill. I

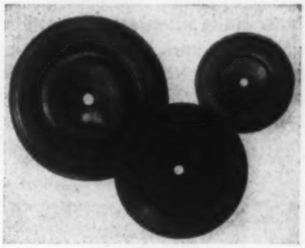


Circle 785 on Page 19

Diaphragm Seals

for temperatures to 500 F

Precision diaphragm seals for aircraft, missiles, rockets, and other applications are available for use at temperatures from −65 to 500 F. Special silicones are combined with fabrics such as Dacron and glass fiber to provide precision diaphragms with virtual immunity to a wide range of chemical and physical environments. Produced to customer requirements, diaphragms retain their shape and resist deterioration. **Pacific Moulded Products Co.,** 905 E. 59th St., Los Angeles 1, Calif. L



Circle 786 on Page 19

Adjustable-Speed Drive

mechanical unit is shaft mounted

Speed-Trol mechanical adjustable-speed drive is shaft mounted to eliminate intermediate transmission elements, such as couplings or sprockets, allowing unit to be mounted directly to drive shaft. Drive is designed for applications where space limitations require output shaft to be at right angles to transmission. It is especially adaptable to applications requiring con-

Another PLUS value..

SEALS IN
LONGER
LIFE

Shafer Self-Aligning Roller Bearing

When you choose a Shafer Bearing, you may be sure it has the *right* seal for *longest life* in your *specific* application.

Whatever the operating condition—whether it's fine abrasive dust from vibrating screens or caustic solutions from industrial washers—the *right* Shafer self-aligning seal is available to assure full bearing protection. Shafer has the industry's largest selection. Mail the coupon.

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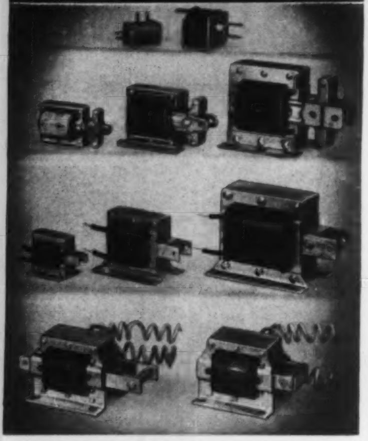
Circle 545 on Page 19

CUSTOM QUALITY STOCK SOLENOIDS FOR EVERY APPLICATION...



available for immediate delivery...

The line consists of 17 models to provide 34 widely differing specifications . . . delivery can be made within 24 hours of receipt of order . . . specifications include: pull and/or push capacities up to 45 lbs., . . . sizes from ¾"x 1⅛" to 3"x 3"... stroke lengths fractional to 2".

All solenoids are built to rigid standards of highest custom quality. Double shading coils provide high sealed pull without excessive AC hum. Electrical characteristics are thoroughly uniform. Units are compactly engineered to extremely close tolerances. Rugged construction provides long service-life under the most strenuous conditions.

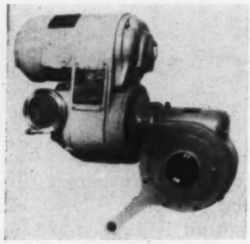
All solenoids in the line can be supplied in any quantity from single units to long-run cost-saving production orders.

Request complete information. Ask for catalog.

DORMEYER INDUSTRIES

3434 N. Milwaukee Avenue, Chicago 41, Illinois

Circle 546 on Page 19



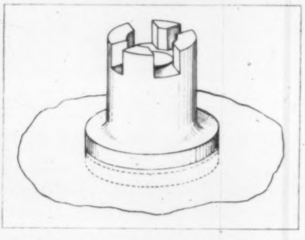
trolled speed in a light, compact power drive. Available in dripproof or totally enclosed constructions, the ¼ to 3-hp units feature speeds from 360 to 5.2 rpm and speed variations from 2:1 to 10:1. **Sterling Electric Motors,** 5401 Telegraph Rd., Los Angeles 22, Calif. L

Circle 787 on Page 19

Fans and Blowers

have integral fan hubs

Airotor small and medium-sized fans and blowers are available with diecast hubs integrally formed with fan spiders and blower backplates. Integral casting of hub with spider or backplate provides rigid, torque-resistant construction. Special external hub shapes, such as a spline, can be die cast as couplings for driving associated equipment. Irregular bore shapes are also produced. **Air Impeller Div., Torrington Mfg. Co.,** Torrington, Conn. B



Circle 788 on Page 19

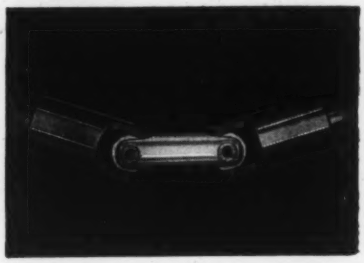
Shaft-Speed Alarm

warns of underspeed or shaft failures

Series 8000 Dazic provides electrical signal control when driven by direct coupling to shafts turning at less than 10 rpm, and operates when driven from shafts turning as slowly as 2 rpm. One application of the internally geared unit is as a shaft failure indicator. Wherever human attention cannot detect shaft failure or reduction in speed, it detects dis-

How Curtis helped a design engineer "BEAT THE HEAT"

This single universal joint in a ribbon-stripping machine was operated at a 34° angle. The joint heated up, wear was excessive. (Curtis Joints have been tested at angles up to 37°, but we do not ordinarily recommend angles greater than 30°.)



Curtis engineers recommended a *double* Curtis joint, which reduced the angle to 17° per joint. Result: no overheating, improved efficiency, longer life.

You can depend on Curtis engineering in any problem of angular power transmission. And you can depend on

CURTIS UNIVERSAL JOINTS

because our catalog torque and load ratings are substantiated by constant tests under production conditions.

14 SIZES ALWAYS IN STOCK — ⅜" to 4" O.D. (6" joints on special order)

Not sold through distributors. Write direct for free engineering data and price list.

TRADE CU MARK CURTIS

UNIVERSAL JOINT CO., INC.

5 Birnie Avenue, Springfield, Mass.

As near to you as your telephone

EXCLUSIVELY A MANUFACTURER OF UNIVERSAL JOINTS SINCE 1919

Circle 547 on Page 19

CHRYSLER
INDUSTRIAL ENGINES

here's why more and more manufacturers and owners of heavy-duty equipment are powering with big output, low cost Chrysler Industrial Engines.

1. Greater endurance: Chrysler Industrial Engines are high-speed, heavy-duty power plants built to stand up under the toughest jobs.
2. Greater efficiency: Chrysler Ind. 56A, for example, has oversquare, short-stroke design that cuts friction loss to a minimum; hemispherical-design combustion chambers produce more power with less heat loss.
3. Greater adaptability: Chrysler Engines can be tailored to your individual requirements with Chrysler optional equipment. All are available as open or closed power units; operate at full efficiency on gasoline, natural or L-P gas.

OPTIONAL EQUIPMENT AVAILABLE ON CHRYSLER INDUSTRIAL ENGINES

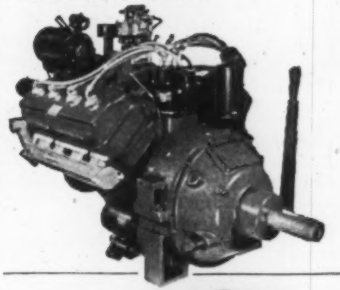
- Chrysler Torque Converter
- Corrosion and Fungus Resistant Electrical System
- Fluid Coupling
- Heavy-Duty Over-Center Clutch and Power Takeoff
- Mechanical or Velocity Governor
- Radio Shielding (24 volt)
- 3, 4 or 5 Speed Transmission
- Propane or Natural Gas Burning Carburetors
- Heavy-Duty, Oil Bath Air Cleaner
- Safety Switches (Low Oil Pressure, High Water Temperature)

INDUSTRIAL ENGINE DIVISION
CHRYSLER CORP., DETROIT 31, MICH.

NEW CHRYSLER INDUSTRIAL ENGINE PRODUCT LINE CATALOG helps you "build" and price an engine to fit your specific application—right at your desk. Call or write.

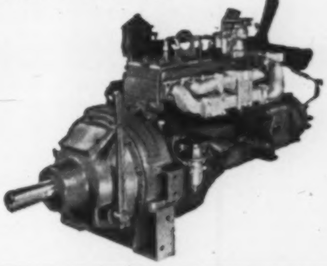
two V-8 models

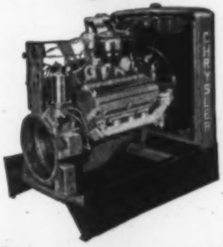
SHOWN: CHRYSLER IND. 56A
354 Cu. In. Displacement



four in-line 6 models

SHOWN: CHRYSLER IND. 31
230 Cu. In. Displacement





Chrysler open power units

Open power units for all engines include complete engine, plus skid base, fuel tank, radiator, instrument panel—complete with instruments—mounted on flywheel housing.

Chrysler enclosed power units

Enclosed power units have complete engine, fuel tank, storage battery, instruments and instrument panel, flywheel, flywheel housing, skid base and completely enclosed sheet metal.

put HEINZE in your designs

POWER

in compact size...

Type SMF
Type SMD

HEINZE UNIVERSAL MOTORS

When you want power in compact series motors, Heinze Universal Motors provide high starting torque, variable speed, reversibility and high output. Originally developed for sewing machines and office machines, they are extremely flexible in design for a variety of uses not requiring constant speed. Flat sided models are especially adaptable for limited space.

Horsepower ratings are from 1/10 to 1/30. Load speed is 7,500 rpm. Standard voltage rating is 115V, AC/DC but motors are supplied for other voltages in AC or DC. Rotation is CW, CCW, or reversing. Optional mounting arrangements include tapped holes on flat side.

Send coupon for new catalog on Heinze Universal Motors — plus the complete line of Heinze sub-fractional horsepower motors and blowers.

HEINZE ELECTRIC COMPANY
685 Lawrence St.
Lowell, Massachusetts

Heinze Electric Company
Dep't D, 685 Lawrence Street
Lowell, Massachusetts

Please send new catalog on Heinze sub-fractional motors and blowers.

Name & Title..............................

Company..............................

Street & No..............................

City & State..............................

Circle 549 on Page 19

crepancy instantly by electrical indication. Self-lubricated control has internal gearing available in 10:1, 5:1, and 2:1 ratios. Single-pole, double-throw, snap-action contacts are rated 10 amp at 125, 250, or 460 v ac. **Winterburn Mfg. Co.**, Whitmore Street, Putnam, Conn. B

Circle 789 on Page 19

Precision-Ground Shafting

in 303 stainless steel and 1/8, 3/16, 1/4-in. sizes

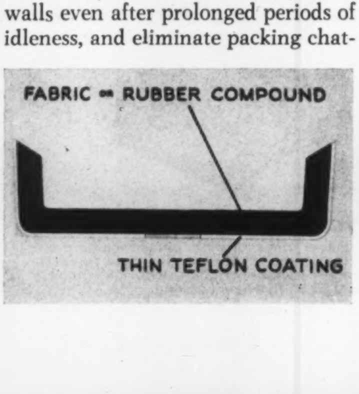
Type A4 precision-ground shafting is held to a tolerance of ± 0.0005 in. in diameter, and is straight and parallel to within 0.0002 in. per in. length. Shafting is available in 303 stainless steel, with surface finish of 8 mu in. or better. Standard shaft sizes of 1/8, 3/16, and 1/4 in. are ground to fit precision ball bearings. Shafting is available in 1/8-in. increments from 1 to 6 in. maximum length. **PIC Design Corp.**, 477 Atlantic Ave., East Rockaway, L. I., N. Y. D

Circle 790 on Page 19

Teflon-Coated Cups

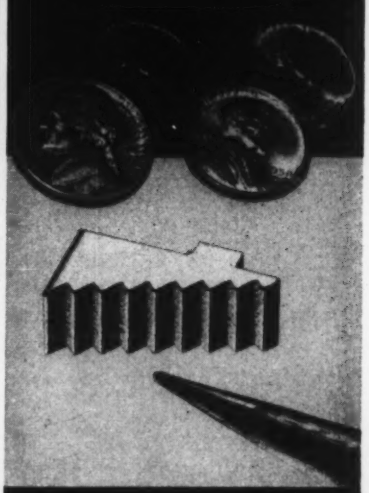
for hydraulic and pneumatic equipment

Teflon-coated cups reduce breakaway torque required to operate cylinders and reduce running friction. They do not stick to cylinder walls even after prolonged periods of idleness, and eliminate packing chat-



Only 8 Cents

... for this intricate Minicast part ...



in quantities of 100,000

Here is another dramatic example of the benefits to be gained from the new Minicast precision process. In addition to an unusually low per unit cost for the part, strict specifications had to be met.

For example, the Minicast process had to provide

- an average maximum radius of .003 on the teeth
- specific tolerances of plus or minus .001
- no tolerance greater than plus or minus .003
- and produce the parts in non-machinable stellite

If you use intricate parts in similar quantity ranges, chances are the Minicast process is your answer to lower costs.

Get the complete story . . . Write for this new descriptive brochure . . . it's free of course

CONSOLIDATED FOUNDRIES AND MFG. CORP.

Casting Engineers
DIV.

2321 NORTH BOSWORTH AVENUE
CHICAGO 14, ILLINOIS

Circle 550 on Page 19

M-R-C **9000** series BALL BEARINGS

originated by M-R-C and manufactured for 40 years—

ideal for applications requiring maximum thrust capacity in both directions, in single-row bearing space.

Advantages of the M-R-C 9000 Series Ball Bearings:

- Equal thrust capacity in both directions.
- Provide maximum load carrying through optimum ball complement.
- Often permit replacement of duplex pair of bearings with single bearing.

Write for Bulletin 1545

M-R-C Engineers are available for consultation on your bearing problems.

MRC
BALL AND ROLLER *bearings*

MARLIN-ROCKWELL CORPORATION
Executive Offices: **Jamestown, N.Y.**

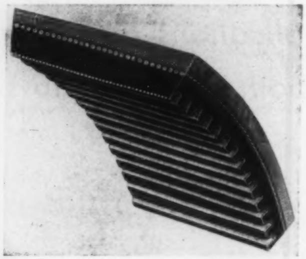
ter and squealing. Cups are for use in hydraulic and pneumatic equipment. **Garlock Packing Co.,** 430 Main St., Palmyra, N. Y. N

Circle 791 on Page 19

V-Belts

for adjustable-speed units

VS replacement belts are available for all popular makes and models of adjustable-speed units. A wide range of sizes is furnished. **Browning Mfg. Co.,** Maysville, Ky. G

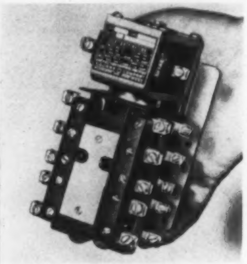


Circle 792 on Page 19

Magnetic Relay

for pilot-duty use on dc control panels

Type D dc magnetic relay is rated at 10 amp, with contact ratings of 125 va for 126 to 600 v, and 250 va for 26 to 125 v. Unit is for pilot-duty applications on dc control panels. It is available with up to ten contacts. **Square D Co.,** 4041 N. Richards St., Milwaukee 12, Wis. K



Circle 793 on Page 19

Self-Locking Nuts

for use on 160,000-psi screws and bolts

Series H14 lightweight, low-height, self-locking nuts are for use on 160,000-psi, short-thread NAS screws and bolts. Anchor, miniature anchor, and gang channel nuts have

RIVETS and NAILS TO "AN" SPECIFICATIONS

Air Force Approved Facilities
Immediate Delivery, Many Sizes
Economically Cold Headed in
STEEL · STAINLESS (including AMS 7228C)
MONEL · INCONEL · COPPER

SPECIAL NAILS RIVETS SCREWS
Hassall

MANUFACTURERS SINCE 1850
JOHN Hassall INC.
P. O. Box 2197 Westbury,
Long Island, New York

Circle 552 on Page 19

ELECTRIC POWER
AT IT'S MONEY SAVING
BEST . . ! .
AIR COOLED

VALLEY
BALL BEARING
MOTORS

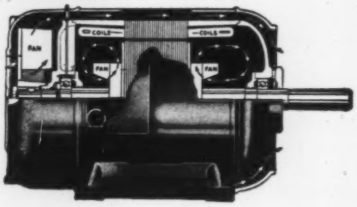
This completely enclosed but... air cooled motor is of the latest design—no foreign matter can penetrate the windings. Its ball bearings and stator core are kept cool by 3 fans which transfer the heat to the frame and end bells — cooling the motor completely — and remember a cool motor runs longer.

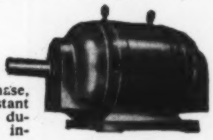
Other Types of Valley Motors
Type SN polyphase, high torque, constant speed, continuous duty, squirrel cage induction.
Type AN single phase, constant speed, continuous duty, repulsion start, induction run.

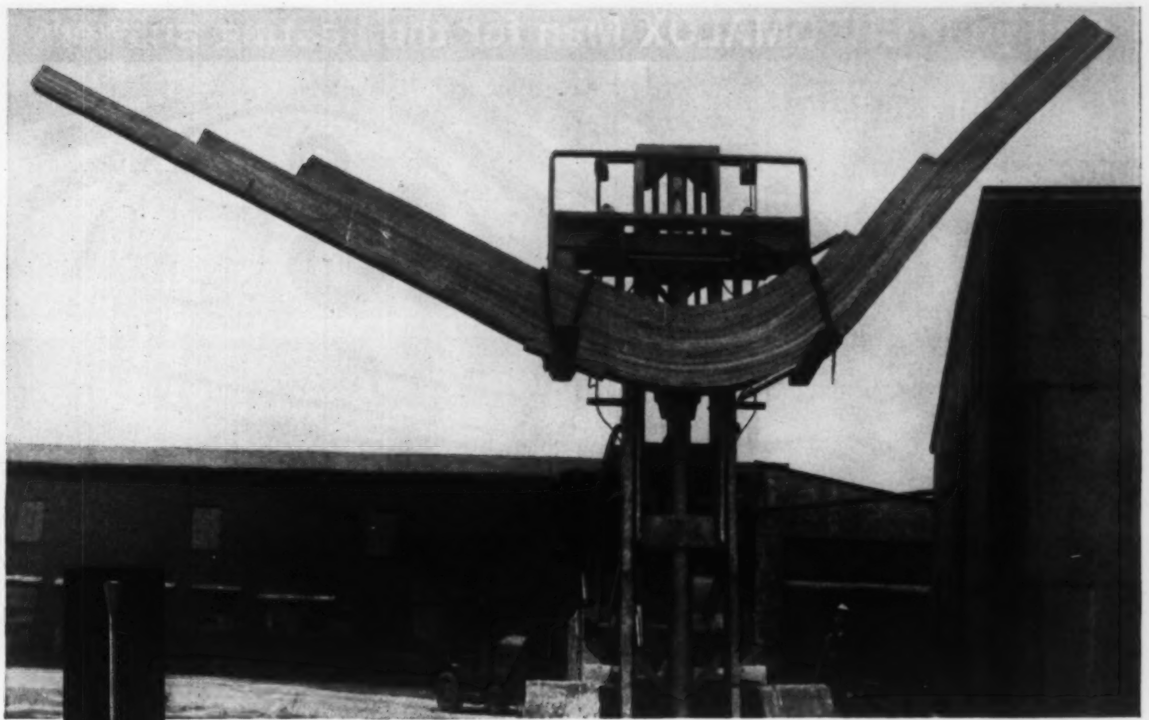
Write for Descriptive Literature.

VALLEY
ELECTRIC CORPORATION
4221 FOREST PARK BLVD. · ST. LOUIS 8, MO.

Circle 553 on Page 19







from paddles...to gunboat stems...

GAMBLE solves problems with WOOD!

The armed forces' solid wood life raft paddles often shattered when dropped from a plane, or splintered when used to "pry" a landing craft onto a beach. Then Gamble Brothers developed a paddle with a shatterproof laminated blade and a dense hardwood handle. Result: a stronger, lighter paddle made with less waste of wood.

The gunboat stem problem was different. Wood, as a non-magnetic material, was specified. But who could engineer and fabricate curved sections of such great cross-sectional depth and width? The answer again: Gamble Brothers, by built-up laminations.

Design problems like these are "all in a day's work" to the wood engineers at Gamble Brothers—a unique organization designing and building a wider variety of wood products than any other U. S. woodworking company. Today they're working in three principal areas: (1) improvement of present wood products (2) development of new wood products (3) product development in combinations of wood and other materials.

Why not present *your* design or component problem to Gamble Brothers? WOOD may be the answer!

FREE booklet illustrates GAMBLE services

This 28-page booklet describes Gamble facilities and services in detail. Includes many photographs of unusual products designed, tested and perfected by Gamble Brothers. Write for your copy today! Gamble Brothers, Inc., 4619 Allmond Ave., Louisville, Ky.

Solving Problems in Wood

If the problem involves wood, Gamble can help!

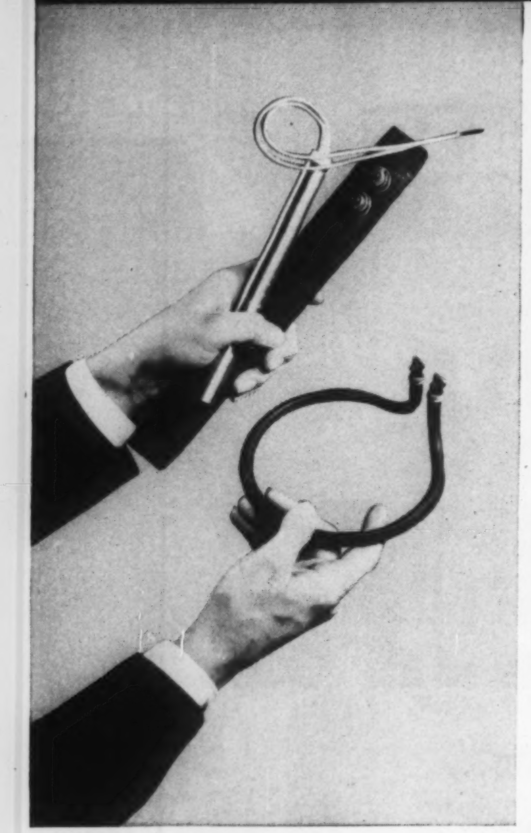
GAMBLE BROTHERS GB GUARANTEED BOND

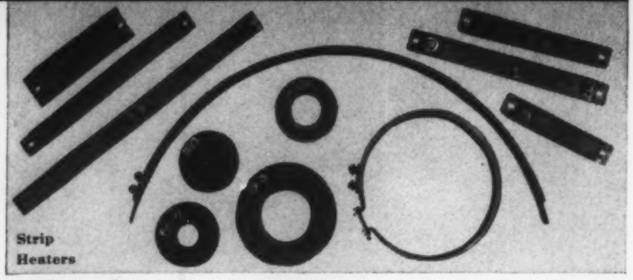
GAMBLE BROTHERS, INC.

4619 Allmond Avenue, Louisville, Kentucky

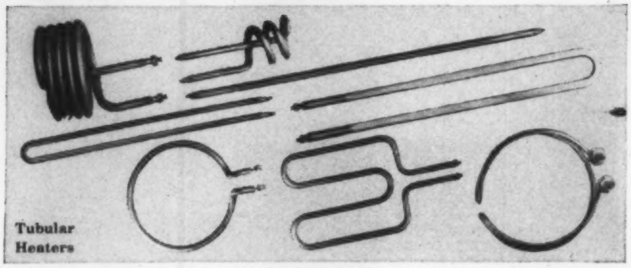
Circle 554 on Page 19

Call your CHROMALOX Man for the heating answers

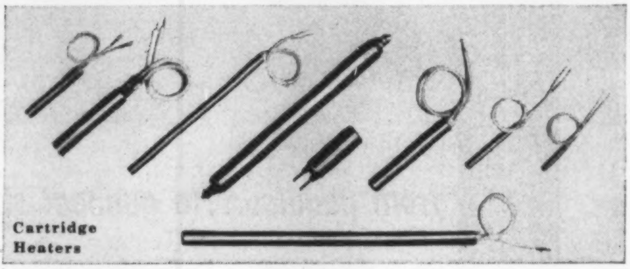




Strip Heaters



Tubular Heaters



Cartridge Heaters

These 3 basic CHROMALOX heaters provide answers to just about any heating problem

Strip Heaters . . . that quickly and easily bolt or clamp to platens, dies, kettles, tanks, pipes, rolls, drums, ovens and air ducts. Lengths from 4 to 96 inches, widths from ¾ to 2½ inches, with cross section curving or lengthwise bending. Available with brazed-on fins.

Tubular Heaters . . . that clamp on, fit into machined grooves, cast into metals, immerse in liquids, install in ovens and ducts. Straight lengths or factory-formed to nearly any contour. Lengths from 6 inches to 30 feet. Triangular or round cross section. Available with brazed-on fins.

Cartridge Heaters . . . that smoothly fit standard drilled holes in dies, platens, molds, extrusion and injection barrels. Special leads available for protection against flexing action, abrasion, moisture or vapors. Diameters from ⅜ to 1¹⁹⁄₆₄ inches, lengths from 1⅝ to 25⅜ inches.

Versatile Chromalox electric heaters are available in sheath materials and wattages to match almost any application to 1100°F. Easy to install, they are fast, clean, safe and economical.

Each has particular advantages. Your Chromalox Man can help you determine the one that best answers your specific problem. He's backed by the world's largest factory stock of industrial heaters, ready for immediate shipment. Why not give him a call. You'll find his phone number listed at the right.

Our new Catalog 60 provides detailed product information and suggests numerous applications for the complete line of Chromalox electric heaters for industry. If you have not yet received a copy, please let us know.

7780

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INDUSTRIAL • COMMERCIAL • RESIDENTIAL
EDWIN L. WIEGAND COMPANY
7575 Thomas Boulevard • Pittsburgh 8, Pa.

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Fraser D. Moore Co.
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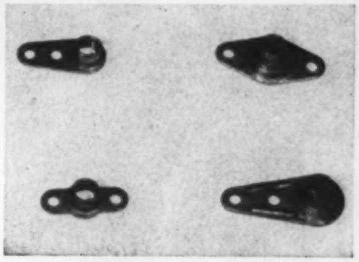


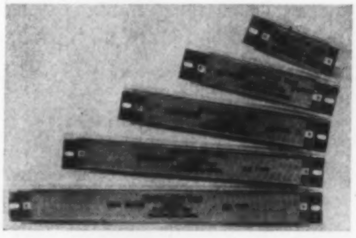
been redesigned to strength level of H14 nuts for use on the 160,000-psi fasteners. Line of hex and anchor nuts meets tensile requirements of MIL-B-7873 and MIL-N-25027. Upper threaded portion of nut is deformed elliptically to produce self-locking action. **Kaylock Div., Kaynar Mfg. Co.**, Box 2001, Terminal Annex, Los Angeles 54, Calif. L

Circle 794 on Page 19

Power Resistors

in power ratings
from 40 to 200 w

New resistors are mounted in direct contact with inner surface of chassis or case in aircraft and missile electronic apparatus. Thus 25 to 40 per cent of heat generated is emitted directly to atmosphere. Units are available in power ratings of 40, 80, 120, 160, and 200 w. Electrical insulation is silicone rubber which is operable continuously at 450 F. Adhesive which provides good thermal transfer from resistor to mounting wall is supplied. Connection tabs are silver-plated brass. **Electro-Flex Heat Inc.**, 83 Woodbine St., Hartford 6, Conn. B



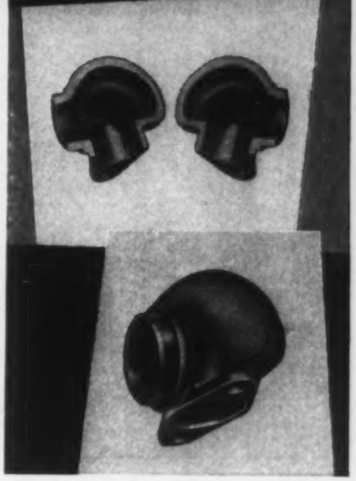
Circle 795 on Page 19

Quick-Disconnect Coupling

for 4000-psi
hydraulic systems

Type 5-5012 quick-disconnect coupling for hydraulic systems in aircraft and missiles meets and exceeds MIL-C-25426 with rating of 4000

two halves *don't* make a hole!



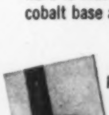
. . . *with* **INVESTMENT CASTING** *it's made in one piece.*

We don't tackle casting problems halfway at Hitchiner.

Here's a cross section where the inside dimensions are greater than the holes. Originally made in sections and assembled — now the whole unit is precision cast and is lighter and stronger.

Where application requirements demand that a part be of intricate shape; of unusual contour, of fine detail, or of metals difficult or impossible to machine — investment casting provides an efficient and economical solution.

Only your production costs are cut in half when you utilize the efficiency of investment casting. You save time and plenty of labor. And . . . you'll have a wide selection of metals; the non-ferrous group, the carbon and low alloy steels, the hard-to-form, hard to machine high alloy steels . . . even cobalt base alloys.

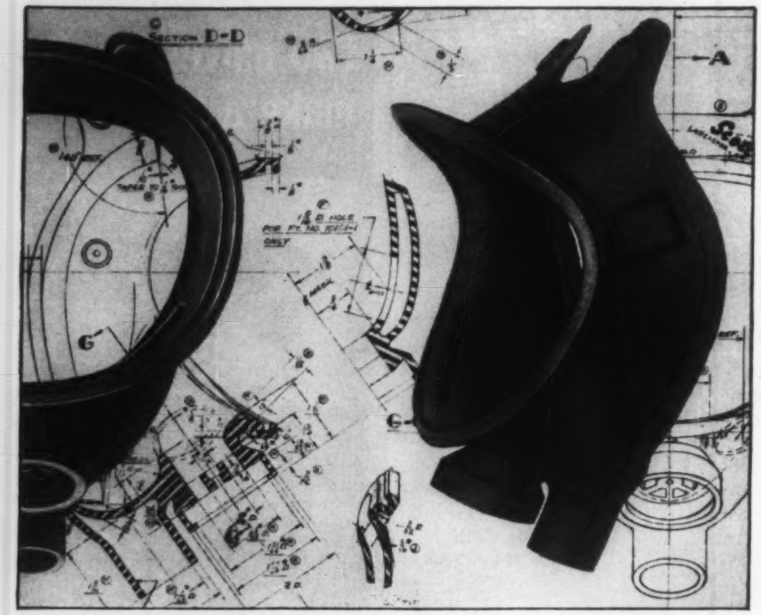


For complete details, see this new illustrated, informative booklet on the art of Investment Casting. It could be the best investment you ever made.

HITCHINER
MANUFACTURING COMPANY, INC.
MILFORD 46, NEW HAMPSHIRE

Representatives in Principal Cities

Circle 556 on Page 19



Courtesy Scott Aviation Corp.

New Molded Profile Reveals Techniques for Better Rubber Specs

In the early stage of planning and design, it was questionable whether this face mask could be molded in rubber—in one piece—practically, yet economically . . . and here's why.

It calls for an ingeniously designed and machined mold to provide for facial contours, air inlets and outlets, undercuts, feathered edges, valve mounts, fastenings, etc.—one of the hardest-to-fill cavities ever encountered. Also, the rubber must be compounded to flow freely inside this complicated form and still maintain its knitting qualities. How was this accomplished?

While the mask was still in the design stage the customer realized the importance of consulting a rubber specialist. From this conference came an exchange of suggestions which led to a practical and functional design that permits molding these masks with unusual speed and economy. Here's the idea.

While a job is still on the drawing board consult with rubber specialists. Suggestions can often be made to eliminate high tooling costs or high priced compounds. End results give you better rubber parts, better performance and lowest cost. Regardless of how simple or complex your rubber needs may be call Continental—specialists since 1903.

Engineering catalog.
In addition to custom-made parts, Continental offers an extensive line of standard grommets, bushings, bumpers, rings and extruded shapes. Hundreds of these are shown in the No. 100 Engineering Catalog. Send for a copy or refer to it in Sweet's Catalog for Product Designers.

Another achievement in RUBBER
CR *engineered by* CONTINENTAL

CONTINENTAL RUBBER WORKS • 1984 LIBERTY ST. • ERIE 6 • PENNSYLVANIA

Circle 558 on Page 19

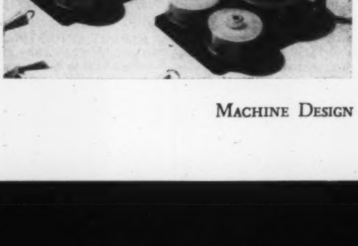
psi. For applications where impulse requirements of the standard are not required, coupling can be used with operating pressures to 6000 psi. Locking device, an integral part of coupling, gives full 360-deg grip on mating part for maximum locking power. Unit withstands extremely high pressure and shock loads, and can be coupled or uncoupled without special tools. Coupling is available in sizes from $1/4$ in. up. **On Mark Couplings Inc.**, 4440 York Blvd., Los Angeles, Calif. L

Circle 796 on Page 19

Spring Motors

incorporate two constant-force springs

Three constant - torque Neg'ator spring motors can be used as design tools by engineers to counterbalance or retract light loads through long deflections without force buildup. Two constant-force springs are used in the motors to provide high output torque. Each stainless-steel spring is mounted on a separate nylon take-up drum, but both exert torque about a single large-diameter output drum, upon which a pulley and stainless-steel cable are mounted. Dual-spring motors have constant output torques of 2.33, 3.12, and 3.90 lb-in. throughout 15 revolutions of output drum. They provide a constant retracting force of 3, 4, and 5 lb respectively through full 6-ft cable extension. Endurance of motors is 4500, 3000, and 2000 minimum



What qualities should a "production" bearing have?

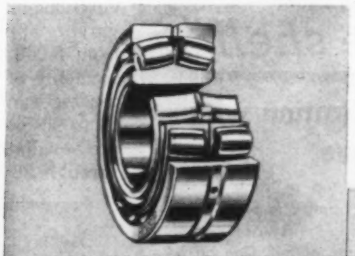
Take a single-row deep-groove bearing, for example.

As SKF makes it, the type shown here sustains heavy radial load—as well as thrust load in either direction—it can be used at normal speeds with grease lubrication or at high speeds with oil. *Yet it is a standard SKF bearing.*

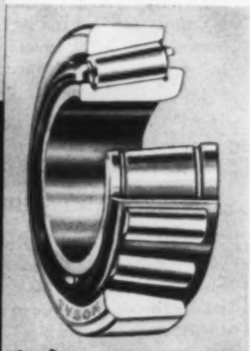
We even mass-produce some sizes of this particular bearing at our automated Altoona (Pa.) plant. You can buy quickly and economically. There are over 100 sizes ranging from over ⅝" O.D. to almost 16" O.D., with various seal, shield and snap-ring combinations.

But why not compare the quality, availability and price of this SKF bearing (or any of the other SKF products) with those you now use? For details, just call any of the 25 SKF sales offices.

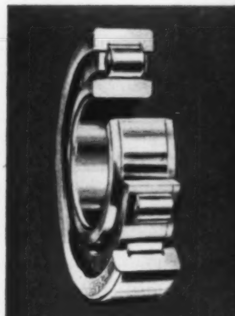
5916



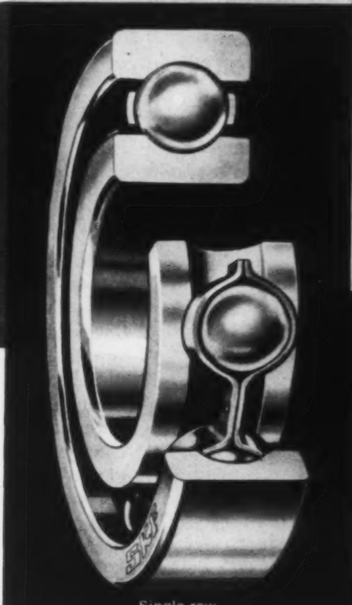
Spherical Roller Bearing



Tyson Tapered Roller Bearing



Cylindrical Roller Bearing



Single-row
Deep-groove Ball Bearing

Spherical Roller Thrust Bearing

Angular
Contact Bearing

Spherical, Cylindrical, Ball, and Tyson *Tapered Roller Bearings*

EVERY TYPE—EVERY USE

SKF®

SKF INDUSTRIES, INC., PHILADELPHIA 32, PA.

®REG. U. S. PAT. OFF.

Circle 559 on Page 19

M • F

gives you product superiority and fast, low-cost assembly with the M•F line of lock nuts and weld nuts in all sizes "off the shelf"

M•F TWO-WAY® LOCK NUT

Open cap nut with 2 way locking feature

for faster application with consistent torque

This all-metal, double chamfered, re-usable prevailing torque lock nut can be applied to bolt threads from either end. The center locking principle permits bolt end to be flush with top of nut. Can be re-applied up to 10 times.

M•F UNI-TORQUE® LOCK NUT

Flange nut with uni-torque locking feature

for high torque consistency in full and jam thickness

This *prevailing-torque* lock nut will withstand terrific vibration and shock loading; retains its locking ability for as many as 10 RE-applications. This is the lock nut that enables you to predict—*and maintain*—UNIFORM bolt tension.

M•F PROJECTION WELD NUT

Pilot type

Recessed type

for low-cost assembly

Solve production delays, cut manufacturing costs—fuse nut to the product in exact location. Engineered for assembly simplification. The welding of nuts to sub-assemblies permits the use of screws or bolts in the main assembly without the need for holding nuts from turning, cutting time and labor.

Both types available with the patented M • F *Two-Way* locking feature. Each type has three welding projections, eliminating rock and guaranteeing a uniform weld.

M•F SPIN LOCK NUT

the nut with the built-in lockwasher

This free-spinning one-piece lock nut eliminates the need for supplemental locking devices such as lock-washers. Cuts purchasing and inventory costs.

WRITE FOR FREE CATALOG

The M • F Products Catalog—valuable data on torque, bolt tension and dimensions as well as on other available products.

MAC LEAN-FOGG Lock Nut Company

5535 N. WOLCOTT STREET • CHICAGO 40, ILLINOIS

Circle 560 on Page 19

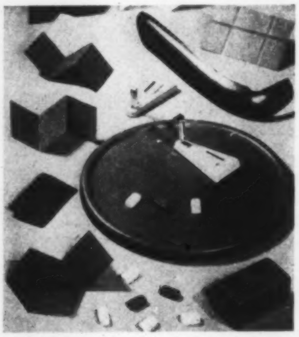
complete operating cycles, respectively. **Hunter Spring Co., Div., American Machine & Metals Inc.,** 1 Spring Ave., Lansdale, Pa. E

Circle 797 on Page 19

Vinyl-Coated Steel

can be formed and embossed without damage to coating

Liquid vinyl plastisols are cured and bonded to sheet steel in a continuous coating process to produce vinyl-coated steel sheet. Liquid vinyl is applied in coatings ranging from 0.008 to 0.02 in. thick, in increments of 0.001 in. Hardness of coating ranges from approximately 60 to 90 Shore A Durometer. Sheets are available in gages from 18 through 28 in. Widths range from 24 to 52 in., and lengths from 30 to 144 in. Steel is also supplied in coils. Maximum depth of 0.005 to 0.006 in. texture embossing can be supplied. Steel can be sheared, slit, punched, lock-seamed, welded, stamped, drawn, or roll-formed without damage to coating or change in color. It withstands elongation of 30 per cent and temperatures to 160 F on a continuous basis without loss of color, texture, or adhesion. **United States Steel Corp.,** 525 William Penn Place, Pittsburgh 30, Pa. F

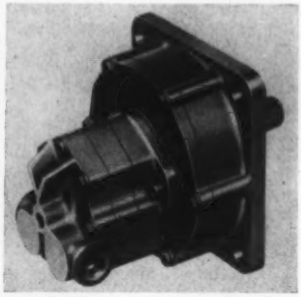


Circle 798 on Page 19

Planetary Gear Reducer

incorporates gear-type hydraulic motor

Designed for use in driving rotary soldering, welding, or heat-treating fixtures, for powering hoists, cranes, or rope drives, for turning turrets and platforms, and for driving elevators and conveyors, new unit



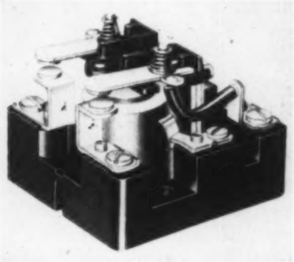
consists of a gear-type fluid motor mounted as part of a planetary gear reducer. High reduction ratio of 4.6:1 assures smooth output even at low shaft speeds. Components provide 150 lb-ft output torque when used with an oil source capable of providing 1500 psi. Unit mounts on SAE standard four-bolt, D-size hydraulic pump mount. **Webster Electric Co.,** 1900 Clark, Racine, Wis. K

Circle 799 on Page 19

Power Relay

has excellent electrical characteristics

No. 2210-U 25-amp, heavy-duty relay has electrical characteristics equivalent to those bulkier devices. Contact arrangement is double pole, single throw, normally open. Coil assembly can be removed and replaced in a short time. Contact assemblies can also be replaced rapidly by removing terminal screws. **Guardian Electric Mfg. Co.,** 1621 W. Walnut St., Chicago 12, Ill. J



Circle 800 on Page 19

Plastic Instrument Cases

provide excellent electrical insulation

Instrument carrying cases are fabricated from Warlite, a melamine plastic bonded to a composition

Mine too...

That's right, Lois. Mom says Dad told her that he and your Dad decided to quit trying to make gears for their machines . . . better to buy them from a gear maker. Now he's not glowering around, mumbling about "costs" anymore. Let's send that CINCINNATI man a really cool record album!

CINCINNATI gears cut your costs ALL the way—
Precision inspection saves your in-plant checking costs . . . Guaranteed delivery dates cut production delays . . . Consistent quality reduces assembly costs . . . High machine utilization means lower gear prices to you.
Send prints for quotation on your gears and custom gear boxes.

CINTI®

THE
CINCINNATI
GEAR CO.

Wooster Pike and Mariemont Ave. Cincinnati 27, Ohio
Custom Gear Makers Since 1907

GEARS, good gears only

Circle 561 on Page 19

WHAT'S YOUR CLAMPING PROBLEM?

WITTEK

HAS THE ANSWER

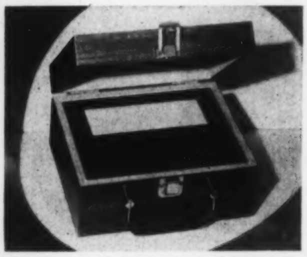
Here is a selection from among the many different types and sizes of hose clamps designed and manufactured by WITTEK. Whatever the hose connecting problem, it's a safe bet that WITTEK (leader for over a quarter century) has the *exact* type and size clamp to do the job right! Let WITTEK help solve *your* clamping problems. Write today.

5187

WITTEK MANUFACTURING COMPANY

4349 West 24th Place • Chicago 23, Illinois

Circle 562 on Page 19



base. Material, stronger and more durable than wood or metal, permanently retains original appearance, provides excellent electrical insulation, and is both crack and stain-resistant. Birch, mahogany, walnut, and other wood grains are among 150 different patterns available. Mounting brackets, built-in fixtures, holes for instrument panels, and other engineered features are provided to customer specification. **Warwick Products Co.,** 1572 Riverbed Rd., Cleveland 13, Ohio. G

Circle 801 on Page 19

Vibration-Damping Material

for temperatures from 20 to 180 F

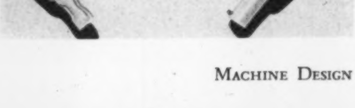
No. 881-658FF vibration-damping material is particularly useful in a variety of applications requiring high damping efficiency at temperatures from 20 to 180 F. Material is built on a base sheet of asbestos fibers. Thin aluminum foils are bonded to the asbestos sheet with adhesives based mainly on chlorine-containing synthetic rubbers. Single-ply material is 0.075 in. thick. For applications demanding more damping, multiple layers can be employed. Material is available at present in sample quantities. **Industrial Div., Armstrong Cork Co.,** Lancaster, Pa. E

Circle 802 on Page 19

Pigtail Connectors

solderless units are nylon insulated

Solderless connectors for pigtail

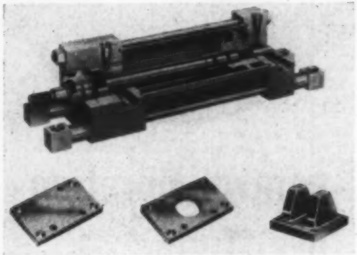


splicing of two or more wires are formed of translucent nylon in a closed-end design. Wires are inserted, then crimped in a single operation. Splice is permanently anchored and insulated, and cannot be loosened by vibration. Connectors have a variety of uses in general industrial wiring, and in the appliance, automotive, and power-tool fields. No. NC-1610 takes any number and combination of wires totaling in gage from No. 16 through No. 10 AWG. No. NC-2214, shown, accepts wires totaling No. 22 through No. 14 AWG. **Electrix Terminals & Connectors Inc.,** 990 E. 67th St., Cleveland 3, Ohio. G

Circle 803 on Page 19

Air Cylinders

in five sizes up to 4-in. bore



JIC square-end, double-acting air cylinders are for holding, positioning, moving work, or making fatiguing motions automatic. Available in five sizes up to 4-in. bore, cylinders are designed for air pressures to 250 psi or hydraulic pressures to 750 psi. Each size is furnished with or without adjustable cushion. Bolt, flush, leg, base, or side-flush mountings are available. Square-end design and interchangeable mounting plates permit mounting in either parallel or 90-deg position relative to ports. **A. Schrader's Son Div., Scovill Mfg. Co.,** 470 Vanderbilt Ave., Brooklyn, N. Y. C

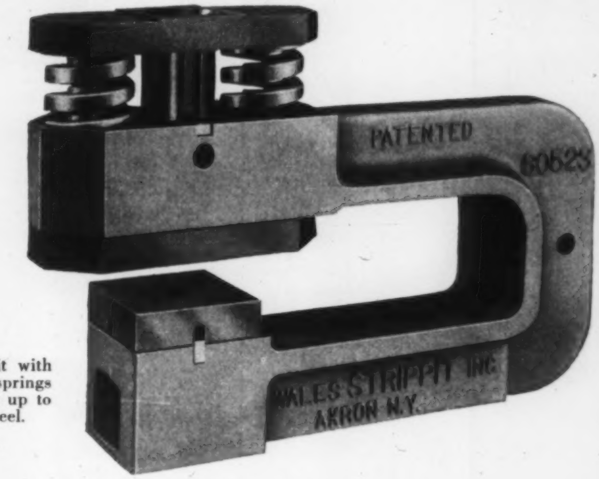
Circle 804 on Page 19

Adjustable-Speed Drive

adjusts exactly to any speed setting

Servotran adjustable-speed drive is furnished with a ten-turn vernier dial, accurately calibrated to pro-

new STRIPPIT PUNCHING UNITS with DUAL-RANGE capacity!



● Strippit unit with mechanical springs for piercing up to .250 mild steel.

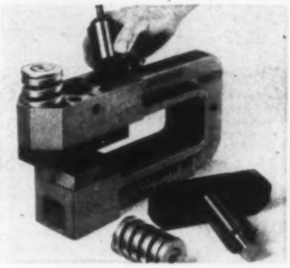
- Up to .250 mild steel, using removable Strippit mechanical springs
- Up to .750 mild steel, with interchangeable Strippit Hydra-Springs
- Convertible from .250 to .750 capacity in seconds, at minimum cost
- One heavy-duty holder for both capacity ranges
- Readily replaceable punch tips and dies — round, obround, square, shaped
- Keyed punch body keeps punches accurately aligned

USING STRIPPIT MECHANICAL SPRINGS

Max. punch dia.	Max. material thickness (mild steel)
1.375	.250
1.250	.375
1.125	.500

USING STRIPPIT HYDRA-SPRINGS

Max. punch dia.	Max. material thickness (mild steel)
1.375	.375
1.250	.500
1.125	.625
1.000	.750



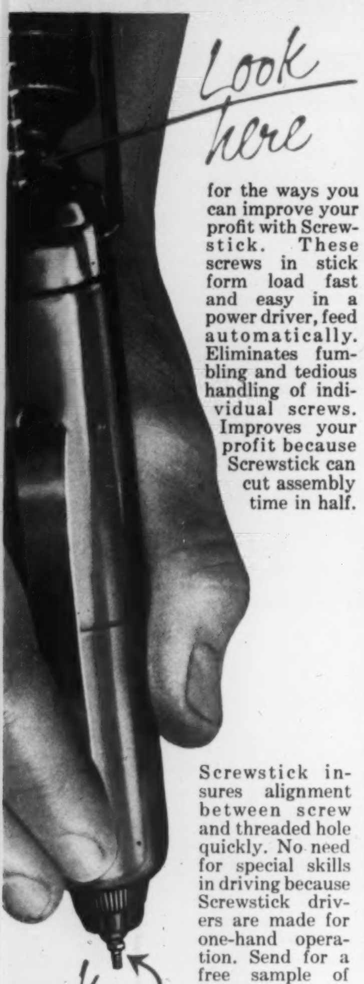
◀ Mechanical springs are easily replaced with Hydra-Springs for punching up to .750 mild steel.

WRITE TODAY for the new Strippit General Catalog. It covers all details on this and all other Strippit units . . . plus the savings in tooling and press time effected with the famous cost-cutting Strippit System of fabrication.

WALES STRIPPIT INC.
216 Buell Road • Akron, New York
Manufactured in Canada by: Strippit Tool & Machine Company, Brampton, Ont.

A UNIT OF HOUDAILLE INDUSTRIES, INC.

Circle 563 on Page 19



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for the ways you can improve your profit with Screwstick. These screws in stick form load fast and easy in a power driver, feed automatically. Eliminates fumbling and tedious handling of individual screws. Improves your profit because Screwstick can cut assembly time in half.

Screwstick insures alignment between screw and threaded hole quickly. No need for special skills in driving because Screwstick drivers are made for one-hand operation. Send for a free sample of Screwstick.

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Profit Improvement Program

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SCREW COMPANY
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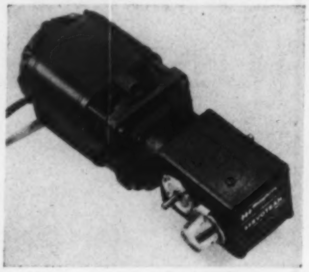
Detroit, Mich.

Circle 564 on Page 19



vide exact adjustment to any speed setting or duplication of previous speed settings. Unit provides output shaft speeds infinitely variable from zero to 1200 rpm, forward and reverse. It is available with motors in 1/100 to 1/40-hp range. **Humphrey Products Div., Humphrey Inc.**, 3794 Rosecrans St., San Diego 10, Calif. L

Circle 805 on Page 19

Pump Impellers

for air and hydraulic service

Bescast pump impellers are manufactured to specification and range in size from a few ounces to 50 lb. Five basic types are shrouded, bucket, fan, mixed flow, and high-speed air units. They are cast in aluminum to provide extreme physical properties, excellent surface finish, and thin sections where needed.

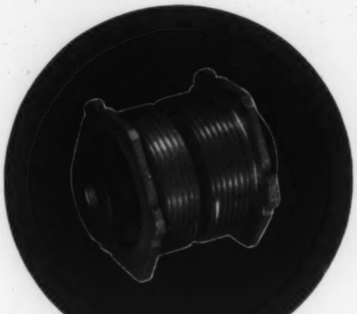
Units are for air or hydraulic service. **Brown Engineering Service Co.**, 29675 Lakeland Blvd., Wickliffe, Ohio. G

Circle 806 on Page 19

Pushbutton Actuators

for use with variety of basic switches

Six 12MA pushbutton actuators fit all pin-plunger basic switches. Two sets of screws, nuts, and lockwashers for attaching various basic



vibration isolators

control vibration over full frequency range

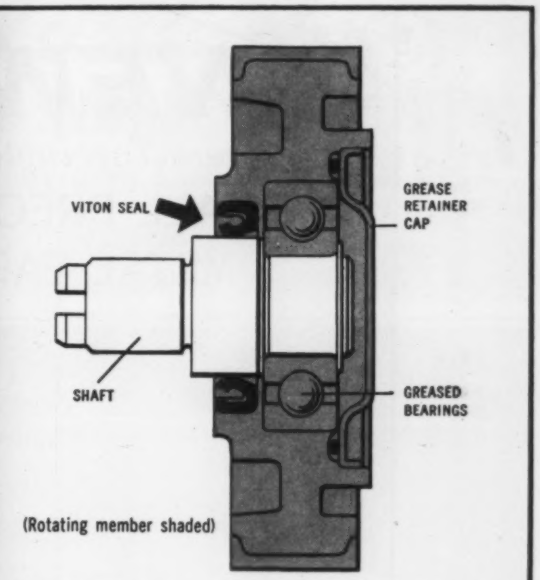
MB ISO-DAMP* mounts do what a conventional isolator cannot. They isolate at both low and high frequencies. Protecting the precision of airborne sighting mechanisms, they not only have the required softness, but also a damping mechanism that restricts resonant build-up to under 3.5 to 1 in any direction.

MB concentrates on standard mounts which are actually in the special performance class. If you have a problem, avail yourself of our 20 years of experience. Send for Bulletin 616A which tells more.

*TM ©

MB MANUFACTURING CO.
A DIVISION OF TEXTRON INC.
1076 State Street
New Haven 11, Connecticut

Circle 565 on Page 19



ROLLER ASSEMBLY — Four of these assemblies support and position the front end of the rotating tub on the 1959 Norge washer-dryer. Shaft is locked into frame of machine. Rotating member turns on shaft as it guides the spinning tub. Shaft seal must withstand high temperatures (250° F. to 300° F.), hot water, and abrasion to prevent drying of greased bearings. VITON proved to be the only synthetic rubber that would give satisfactory performance under these conditions.

On New Norge Washer-Dryer Combination

VITON shaft seal gives best resistance to 300° F. heat, grease, abrasion

TRADEMARK

The rotating tub of the new Norge automatic washer-dryer combination rides on four roller assemblies containing bearings that are permanently sealed in grease (see diagram). These bearings are expected to last as long as the appliance—in spite of hot, dirty detergent water and high temperature air that come in contact with the assembly.

One obvious engineering requirement was the use of a flexible seal between shaft and rotating member of the roller assembly to prevent water and air from attacking the bearings. The *problem* was to find a synthetic rubber that would give good performance in spite of grease, oxidation and abrasion at operating temperatures of 250° F. to 300° F. (Because of soil suspended in the wash water, abrasion was found to be particularly severe where the rotating seal rubbed against the stationary shaft.)

Tests showed that seals made from well-known synthetic rubbers failed at the 300° F. temperatures. Special high-temperature synthetics were inadequate in abrasion resistance. A material was needed that possessed good mechanical properties at high temperatures. Du Pont VITON synthetic rubber was the solution.

A shaft seal made of VITON gave Norge engineers the required resistance to grease, oxidation and abrasion—even at temperatures over 300° F. No other synthetic rubber tested could come near this record. As a result, VITON was adopted, and is now specified for this shaft seal on the 1959 Norge combination.

Learn more about VITON, for gaskets, diaphragms, O-rings, hose, tubing, and molded parts where you need a synthetic rubber with resistance to heat (400-450° F. continuously . . . up to 600° F. intermittently) and corrosive fluids . . . *plus* excellent mechanical properties. Write for complete technical facts to E. I. du Pont de Nemours & Co. (Inc.), Elastomer Chemicals Department MD-V4, Wilmington 98, Delaware.

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Better Things for Better Living . . . *through Chemistry*

SYNTHETIC RUBBER

NEOPRENE
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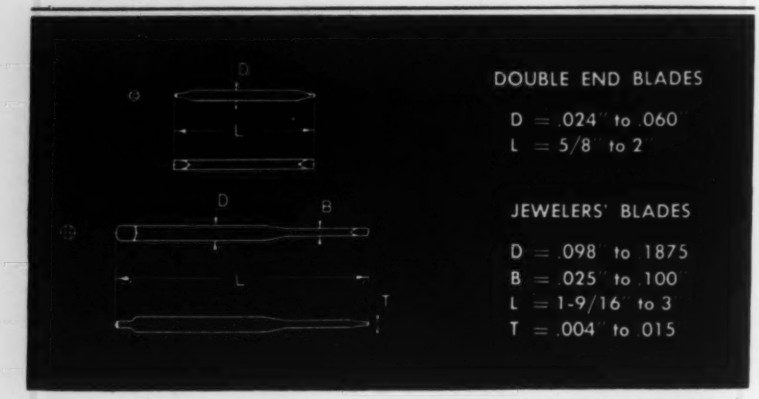
VITON™
ADIPRENE®

NEWS

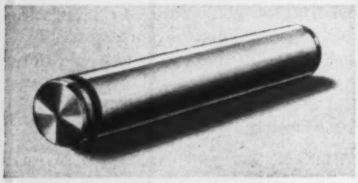
from Torrington on

SMALL PRECISION METAL PARTS



"Custom manufacture" has a special meaning at Torrington, where our Specialties Division produces a tremendous variety of small precision metal parts. For our engineers often help in designing parts for our customers, and as frequently develop special equipment or methods for most efficient production.

For example, one of our current contracts is for jewelers' screwdriver blades. In this case, our engineers decided to swage these parts to give the required high-strength characteristics without stress concentration points and tool marks. Other features of these parts are good dimensional accuracy and closely controlled heat treating for hardness and temper.



In another case, we received a blueprint of a special pinion axle with an accurately cut retaining ring groove at one end. The customer inquired whether this part could be produced at about the same price as a straight cylindrical axle with an uninterrupted OD. The answer was "Yes!" Specialties engineers decided that high-speed cutoff and groove-turning equipment would have to be built to cope with the high volume involved. Special pinion axles have now joined the great number of parts being produced by Torrington Specialties Division.

Whatever the part, whatever the operation—even operations tailored to the part requirements—Torrington's Specialties Division is uniquely equipped to handle your small precision parts contracts. Highly specialized fluting operations, for example, permit volume production to close tolerances. Precision swaging, knurling, forming, milling, drilling are among other operations for which we are fully equipped. Advanced heat treat and statistical quality control methods help provide the quality product you require.

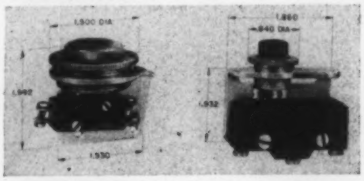
For help with your custom-built small precision metal parts in large quantities, just circle our number on the reply card. Or have your Purchasing Agent call our area salesman, or write direct to:

The Torrington Company, Specialties Division, 626 Field Street, Torrington, Conn.

TORRINGTON SPECIAL METAL PARTS

Makers of Torrington Needle Bearings

Circle 567 on Page 19



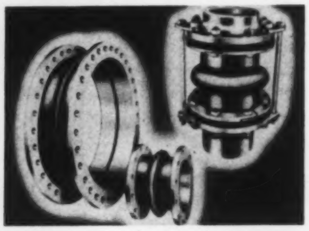
switches are furnished with each actuator. Series includes $\frac{1}{2}$ and 1-in. button sizes available in red, green, or black plastic. Both button sizes fit panels from 0.06 to 0.312 in. thick. Switch mounting holes, adjustable in three steps, allow user to position basic switches on actuators for best button travel. **Micro Switch Div., Minneapolis-Honeywell Regulator Co., Freeport, Ill.** K

Circle 807 on Page 19

Expansion Joints

for pressure or vacuum operation

Expansion joints, made for chemical, oil, water, or exhaust steam lines operating at temperatures from 180 to 200 F, are available in sizes from $\frac{1}{2}$ to 78 in. For either pressure or vacuum operation, they offer high strength and flexibility, and compensate for misalignment. Joints eliminate electrolysis, are not subject to embrittlement with age, and offer maximum resistance to shock. Spool-type joints (shown) are especially compact and provide long life at elevated temperatures. **Manhattan Rubber Div., Raybestos-Manhattan Inc.,** Passaic, N. J. C



Circle 808 on Page 19

Epoxy-Glass Laminate

has excellent electrical characteristics

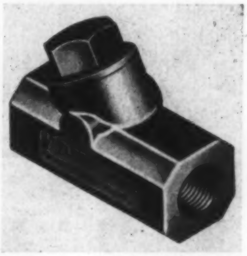
Insurok T-525 and T-525N laminate meets military specification MIL-P-18177B, Type GEE, and NEMA G10. Both grades are available copper-clad and nonclad. T-

525 copper-clad is for normal printed-circuit applications, and T-525N copper-clad withstands cyanide solutions for gold plating. Printed circuits on T-525 and T-525N can be made flush with adjoining surfaces by using heat and pressure. Standard sheet size is 36 x 42 in. and thicknesses are 1/32 to 1 in. for unclad Insurok and 1/32 to ¼ in. for copper-clad. Properties include excellent electrical characteristics at high humidity and high dimensional stability. Laminate can be punched at room temperatures. **Richardson Co.,** 2700 Lake St., Melrose Park, Ill. J

Circle 809 on Page 19

Flow-Control Valve

has minimum pressure drop



Floreg valve is an adjustable unit that works with other components of a fluid circuit to time, sequence, or co-ordinate circuit operation. It controls rate at which a gas or liquid flows in one direction, and allows free flow in opposite direction. Valve is self-cleaning, has minimum pressure drop, and is noiseless. Working pressures are 250 psi maximum pneumatic, 500 or 2000 psi maximum hydraulic. Operating temperature range is −40 to 200 F. Three sizes available are ¼, ⅜, and ½ in. NPT. Valve is corrosion resistant. **Industrial Products Div., Westinghouse Air Brake Co.,** P. O. Box 36, Wilmerding, Pa. G

Circle 810 on Page 19

Lightweight Lock Nut

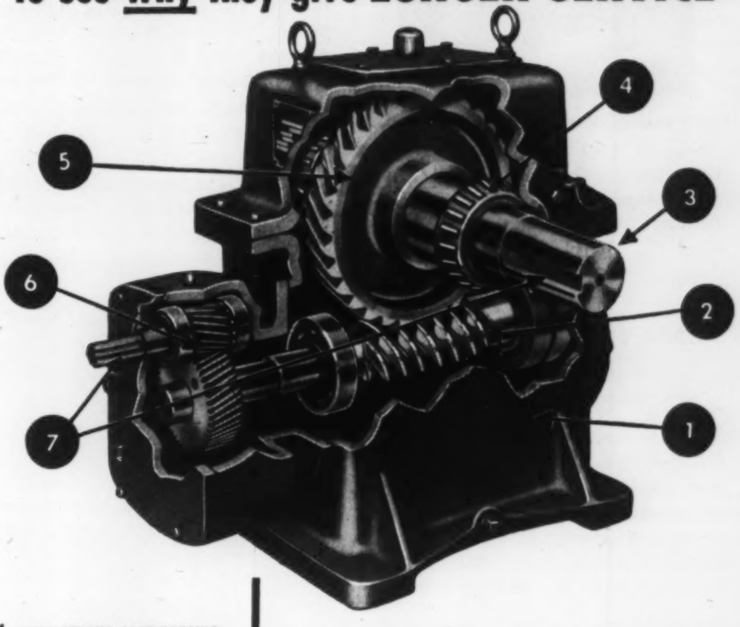
for temperatures to 800 F

FN 812 cold-forged nut of austenitic stainless steel is for aircraft and missile uses at temperatures to 800 F. External hexagon drive unit meets locking torque and vibrational re-

Look Inside a Foote Bros.

ENCLOSED WORM GEAR DRIVE

to see why they give ***LONGER SERVICE***



1 **EXTRA STRONG CAST HOUSING**
Provides rigid mounting and alignment of caps and bearings. Made of high quality cast iron.

2 **PRECISION ALLOY STEEL WORM**
Integral with oversize shaft. Carefully matched to worm gear for quiet, trouble-free service.

3 **OVERSIZE OUTPUT SHAFT**

4 **HEAVY DUTY, EXTRA LARGE BEARINGS**
Oversize bearings used throughout unit. Worm bearings are combination single row radial and angular contact ball bearings. Input shaft bearings are single row radial type.

5 **WORM GEAR**
Precision generated from uniform density, high hardness virgin bronze alloy casting. High load carrying capacity.

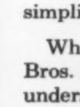
6 **HEAT TREATED HELICAL GEARS**
Shaved for full tooth contact. Pinion integral with input shaft. Gear locked in position on worm shaft extension.

7 Just one of 10 different types, in a wide range of sizes, ratios and shaft arrangements.

One look at the oversize bearings, larger shafts, precision made gearing and the sturdy housing of a Foote Bros. Hygrade Worm Gear Drive tells you that *this* is a workhorse unit that will stand up and deliver under the toughest conditions.

Notice the carefully balanced design . . . greater mass where it's needed . . . the elimination of weight when it contributes nothing to efficiency . . . strength and toughness at the right places . . . the correct gear alloys . . . the compact design, and above all, the simplicity and ruggedness of this unit.

When you know the *inside* story of Foote Bros. Hygrade Worm Gear Drives, you can understand why they have built a reputation for quality, dependability, and performance that is unmatched by others.



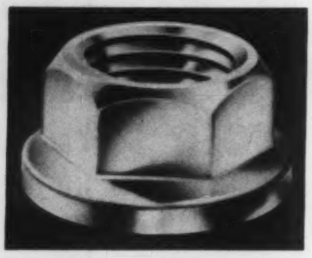
Write for Engineering Manual HGB. It contains complete information on Hygrade Enclosed Worm Gear Drives.

100 YEARS SERVING INDUSTRY 1859-1959 FOOTE BROS.

Better Power Transmission Through Better Gears

FOOTE BROS. GEAR AND MACHINE CORPORATION
4567 SOUTH WESTERN BOULEVARD • CHICAGO 9, ILLINOIS

Circle 568 on Page 19



quirements of specification MIL-N-25027. It is up to 60 per cent lighter than comparable sheet-metal nuts. Sizes presently available are No. 4 through 3/8 in. **Standard Pressed Steel Co.,** Jenkintown, Pa. C

Circle 811 on Page 19

Turbine Flowmeters

for pressures to 5000 psi and temperatures to 1000 F

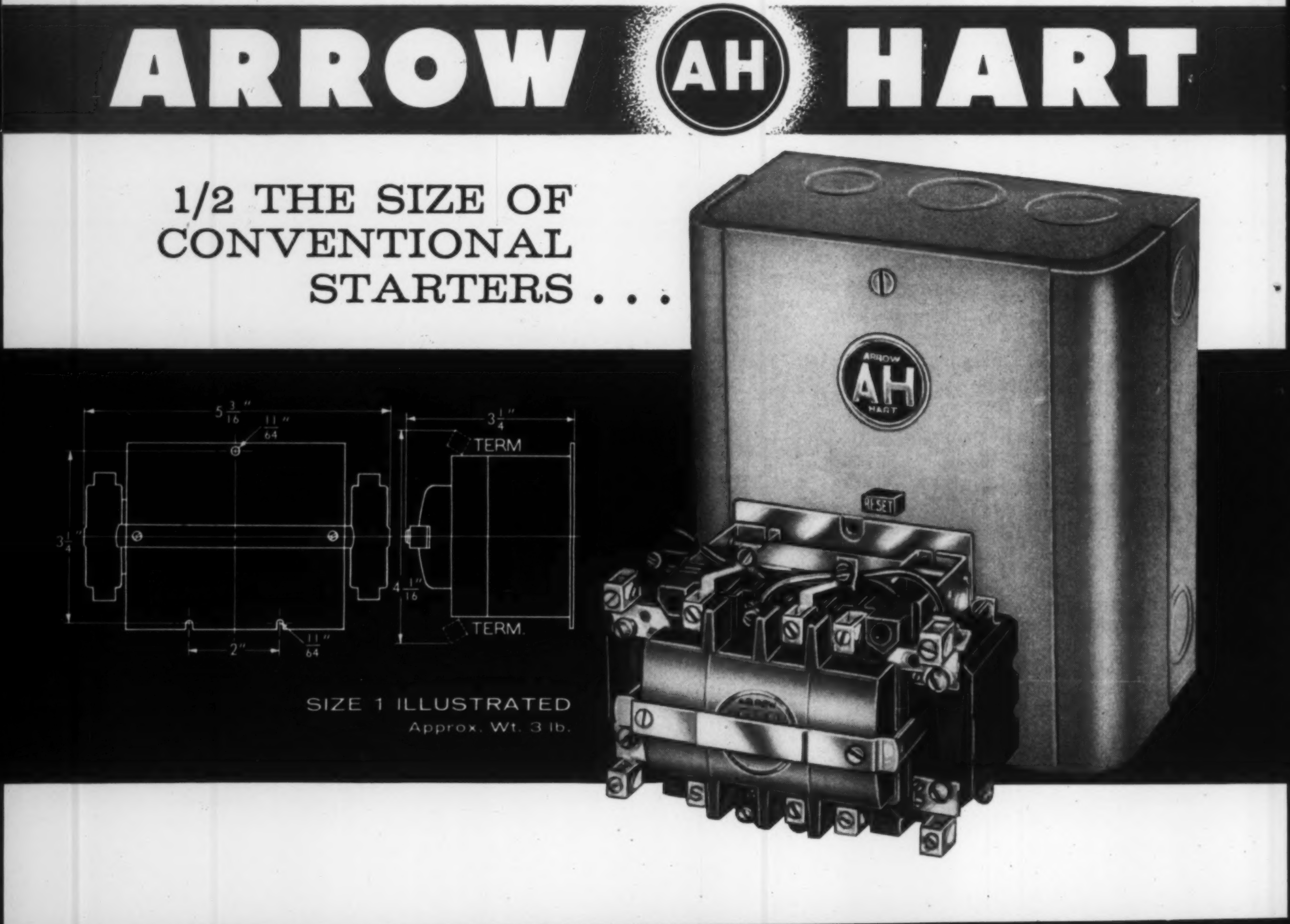
Type 20 turbine flowmeters handle jet fuel, gasoline, oil, water, acid and alkali chemicals, and other liquids with pressure drop of less than 5 psi at maximum rated flow under normal conditions. Linear flow ranges are available to 35:1, depending on flowmeter size. Units measure liquid flow within ±1/2 per cent accuracy at pressures to 5000 psi and temperatures from −455 F to +1000 F, depending upon viscosity. Improved units have single-bearing design which lowers rotor inertia and friction. Low rotor inertia provides excellent transient response time of 3 millisec. Smaller and lighter than previous models, flowmeters are stainless steel throughout. They can be disassembled and reassembled with no effect on calibration. Units are available in standard sizes from 8-4 to 32 with either AN thread or ASA flanged connections. Group covers flow ranges between 0.25 and 250 gpm. **Cox Instruments Div., George L. Nankervis Co.,** 15400 Fullerton Ave., Detroit 27, Mich. H

Circle 812 on Page 19

Static Power Inverter

produces stable power output of 250 va

Solid-state static power inverter, utilizing transistor and magnetic-amplifier circuitry, converts a 26 to 30-v dc source to a 115-v, 400-cps, single-phase ac source. Designed to produce a stable power output of 250 va, unit is for use in missiles, missile checkout systems, aircraft and ground equipment, gyro-wheel power supplies, air or spaceborne computers, and radar. It also has applications in automation, telemetry, atomic-energy programming, and in jet-aircraft ignition systems. Unit has life expectancy of 20,000 hr under continuous operation. It is designed to operate with conventional circuit breakers or fuses. Inverter withstands vibrations of 10 to 2000 cycles and high shock to 30 times its weight. Unit meets mili-



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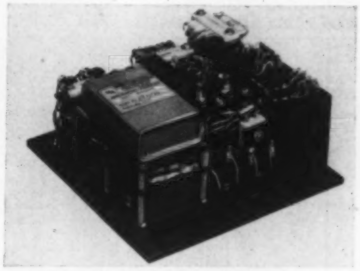
1/2 THE SIZE OF CONVENTIONAL STARTERS . . .

SIZE 1 ILLUSTRATED
Approx. Wt. 3 lb.



tary specifications MIL-E-5400 and MIL-E-5272. **Magnetic Amplifiers Inc.**, 632 Tinton Ave., New York 55, N. Y. D

Circle 813 on Page 19

Precision Film Resistor

N-style unit is epoxy coated

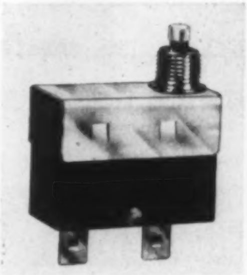
N-style resistor, produced in ½-w (N70) and ¼-w (N65) sizes, provides excellent insulation and moisture resistance. The epoxy-coated unit withstands chlorinated hydrocarbon solvents used to clean flux from printed-circuit boards. N65 (¼-w) has applications in transistorized circuitry. It meets MIL-R-10509C, characteristic B. Both units are particularly suitable for use in computers and missiles. **Electrical Components Dept., Corning Glass Works**, Bradford, Pa. F

Circle 814 on Page 19

Circuit Breaker

protects 110-v ac motors through ½ hp

Model 8150 Klixon circuit breaker, with ratings at intervals from 5 to 25 amp, provides remote, overcurrent protection for 110-v ac motors through ½ hp. Unit is designed especially for appliances and heating and air-conditioning equipment. It is also applicable for wire protection of mobile equipment and for component protection in units such as battery chargers. Model has an indicating band to facilitate locating tripped circuit. Double-break contacts help to maintain calibration by reducing contact erosion. Unit weighs only 1 oz. **Spencer Div., Metals & Controls Corp.**, 34 Forest St., Attleboro, Mass. B



Circle 815 on Page 19

DC Motors

supply constant or adjustable speed

Flexitorq motors provide faster response, wider speed range, and higher overload capacity in a lighter, more compact machine than previous units. Motors supply constant or adjustable speed for driving machine tools, metal rolling, drawing or forming machines, cranes, hoists, conveyors, dynamometers, test stands, and automated machinery. Units are available in ratings of 1 to 200 hp, in dripproof and dripproof-guarded enclosures. Improved

MOTOR CONTROLS

THE *NEW MODEL* 58 "RA" STARTER

This new starter features the exclusive Arrow-Hart "Right Angle" mechanism with magnet operating through a simple bellcrank lever. The resulting mechanical advantage lets a much smaller, lighter magnet outperform older, direct-acting types. Control size and weight are reduced by half . . . performance and dependability are greatly improved.

New Model 58 Size 1 Starters offer:

- **Wide Voltage Range Coils**
  Standard coil voltages are 110-120, 208-230, 440-480 and 550-600, at 60 cy.
- **Epoxy-Resin Encased Coils**
  Better protection against physical abuse, humidity, oil, fungus, shock, vibration, and other environmental conditions.
- **Wrap Around Enclosures**
  Make starters easier to install, wire, inspect and maintain.
- **Wiring Lugs**
  Make straight-thru front wiring easy.

Available in a complete line, NEMA Sizes 0 through 5, in Non-Reversing, Reversing Multi-Speed, Reduced Voltage Starters and others.

Write today for Motor Control Handy Reference Catalog No. 14 to The Arrow-Hart & Hegeman Electric Co., Dept. MD, 103 Hawthorn St., Hartford 6, Conn.

ARROW-HART of HARTFORD

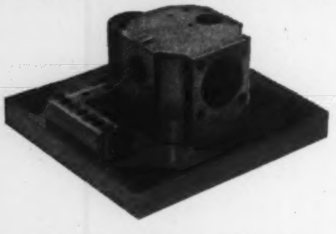
Quality since 1890

MOTOR CONTROLS • ENCLOSED SWITCHES • APPLIANCE SWITCHES • WIRING DEVICES

Circle 569 on Page 19

LRC LUZERNE

PLASTICS AND HARD RUBBER



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LUZERNE RUBBER COMPANY
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Circle 570 on Page 19

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by John D. Vandenberg and C. Thomas Goldsmith

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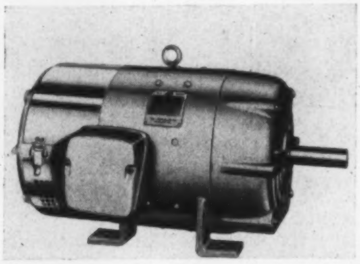


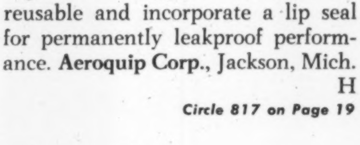
performance characteristics include faster acceleration, deceleration, reversing, and speed changing, made possible because of low-inertia armature and improved commutating ability. Class B insulation is used throughout, permitting intermittent high overloads without damage to insulation system. **Louis Allis Co.**, 427 E. Stewart St., Milwaukee 1, Wis. K

Circle 816 on Page 19

Pneumatic Hose

has 24,000 psi burst pressure

No. 678 Teflon hose for 6000-psi pneumatic systems has minimum burst pressure of 24,000 psi. Hose is designed for severe requirements of missile pneumatic charging systems. Teflon tube with zero moisture absorption and antiadhesive surface permits fast, easy purging and dehydration of hose lines and equipment. Spirally wound stainless-steel wire overlaying stainless inner braid reinforces hose, which has a stainless braided cover. The flexible hose is available in $\frac{3}{8}$ and $\frac{1}{2}$-in. sizes. Segmented fittings for the hose are reusable and incorporate a lip seal for permanently leakproof performance. **Aeroquip Corp.**, Jackson, Mich. H



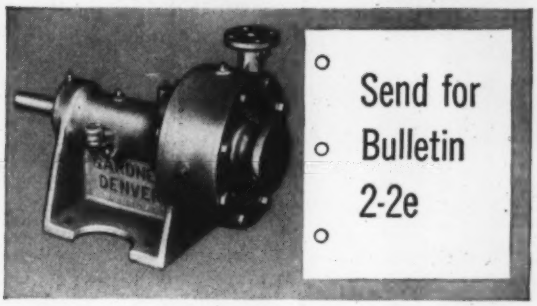
Circle 817 on Page 19

Silicon Rectifiers

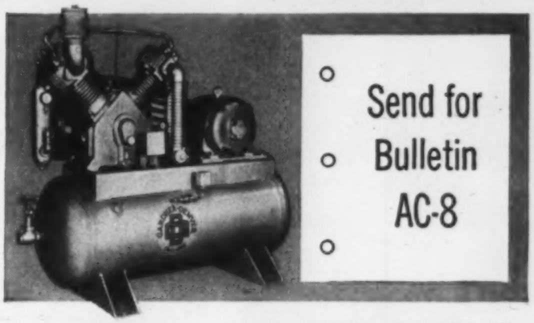
miniature units have 12-amp rating

Series X12F silicon rectifiers assure low forward voltage drop, low leakage, and high uniformity of char-

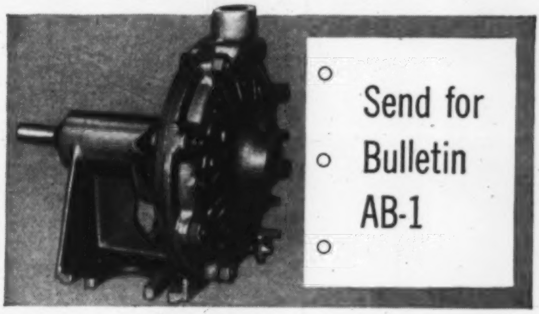
If your design moves water, uses air power . . . design in these dependable components



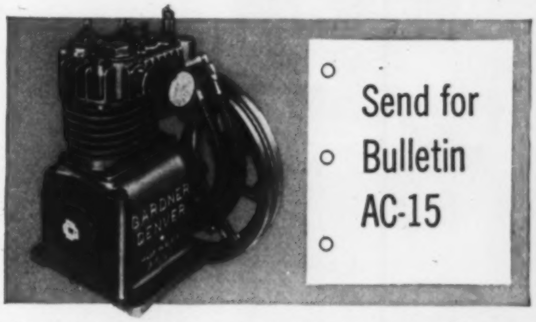
High-speed, high-head pumps for big water volume — Gardner-Denver BH centrifugal pumps. 1", 1½", 2" and 3" sizes with capacities from 55 to 550 gpm.



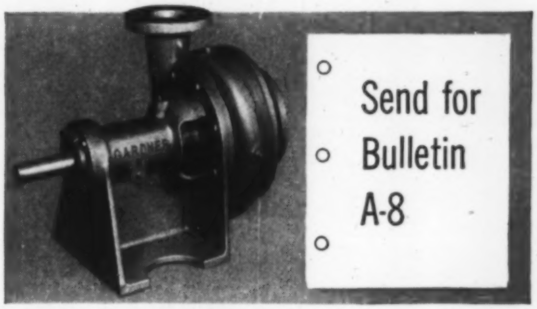
Plus-value compressor outfit — Gardner-Denver ADL displaces 100 cfm at 125 psi. Two-stage, air-cooled.



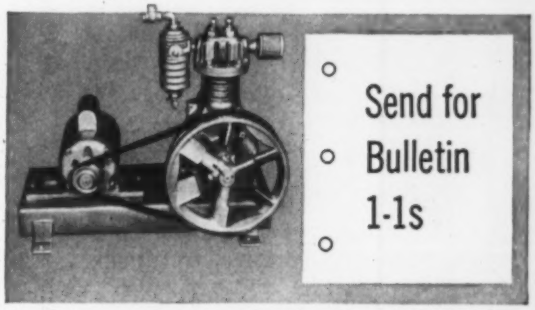
Reverse rotation without alteration—Gardner-Denver CAY 1½" centrifugal pumps. Handle up to 65 gpm.



Designed to outlast any other small compressor—Gardner-Denver ADD two-stage compressors. Rated at 25 cfm displacement.



Top pumping efficiency over broad service range — Gardner-Denver BL centrifugal pumps. 2", 3", 4", 5" and 6" sizes provide capacity range from 100 to 1600 gpm.



Compact compressor package provides low-cost, oil-free air—Gardner-Denver CACB supplies 4 to 5 cu. ft. of air per min. Suitable for discharge pressures of 40 to 100 psi.

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Gardner-Denver Company, Quincy, Illinois
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Circle 572 on Page 19

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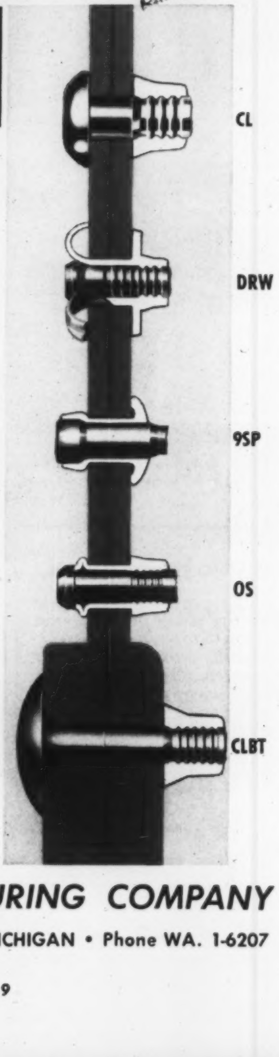

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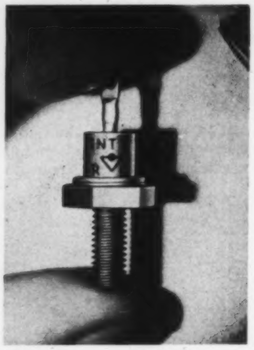
Circle 573 on Page 19

acteristics over entire operating-temperature range. Units provide 12-amp current output over a peak inverse voltage from 50 to 500 v. All-welded construction assures high resistance to vibration, shock, and temperature extremes. Units are nickel-plated to provide minimum contact resistance and prevent corrosion. Eyelet construction insures fast, easy wiring into production assemblies. **International Rectifier Corp.**, 1521 E. Grand Ave., El Segundo, Calif. L

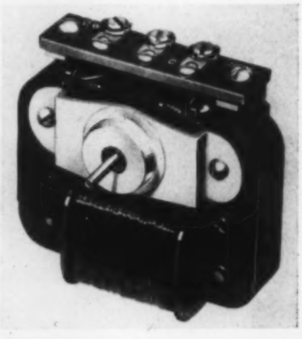


Circle 818 on Page 19

Tachometer-Generator

has nearly linear voltage from 1000 to 3000 rpm

Reversible shaded-pole motor, designated AYAE, fulfills requirements of an ac tachometer or rate generator. With rated ac voltage applied to main winding, voltage, proportional to speed at which rotor is driven, is generated in shading windings. Voltage is nearly linear from 1000 to 3000 rpm. Generated voltage from a typical rate generator with low-impedance shading coils (150 ohms) is 2 v per 1000 rpm; it can be increased to 10 v per 1000 rpm using shading coils



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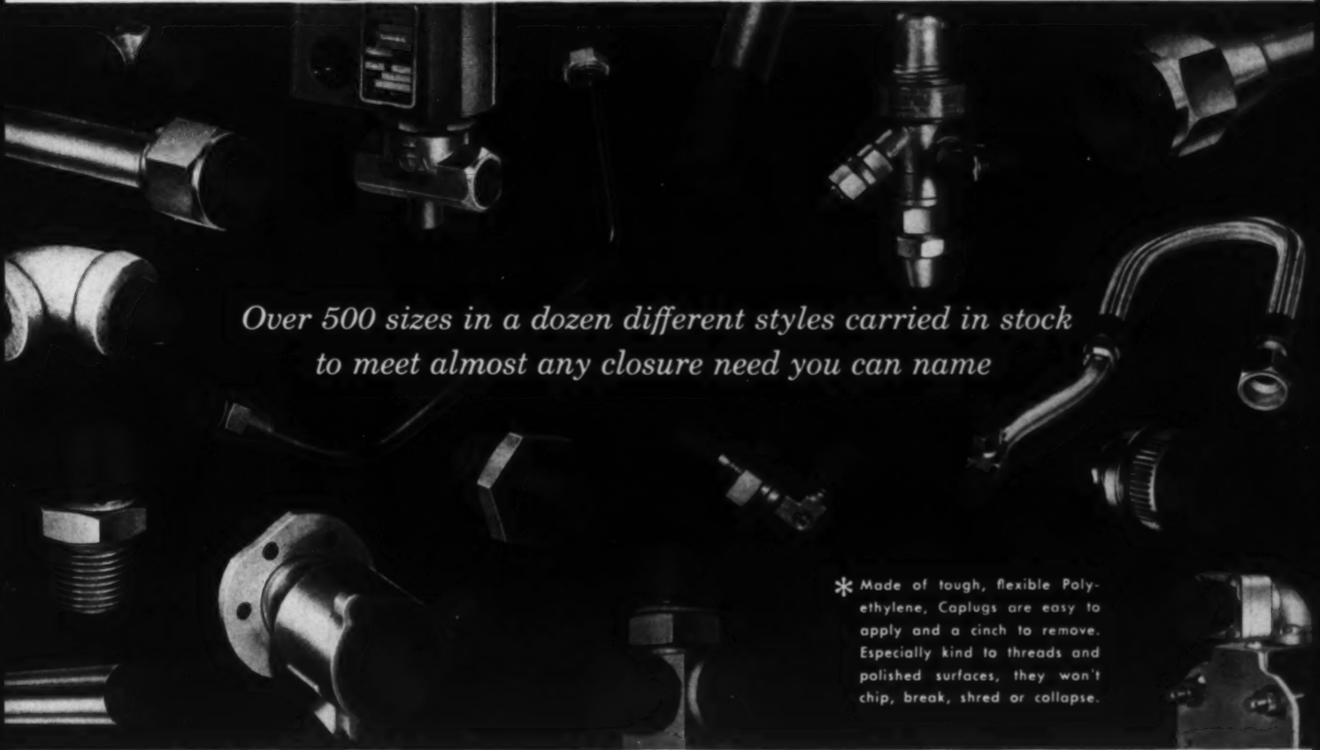

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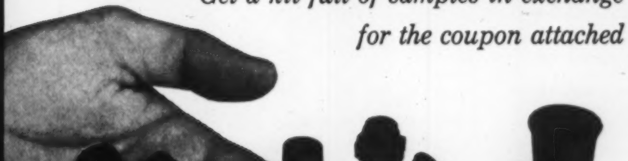

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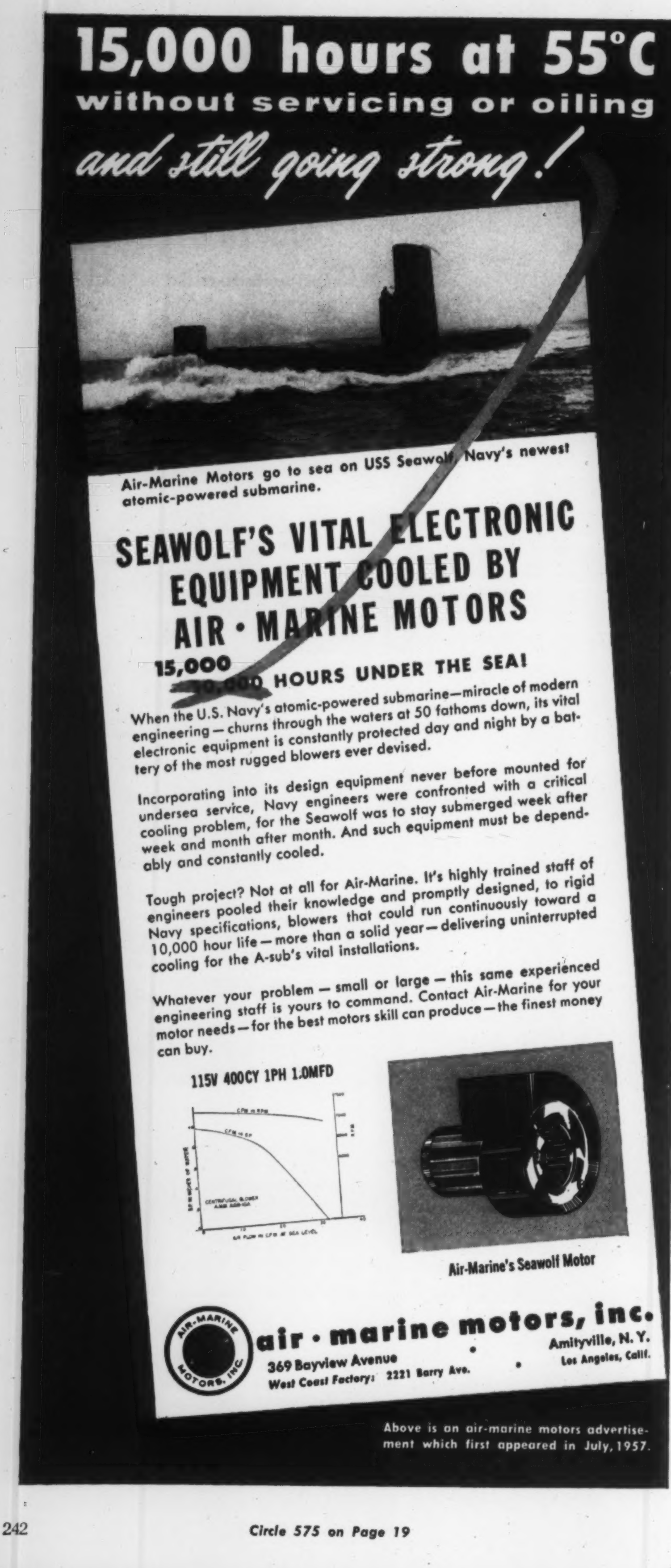

15,000 hours at 55°C
without servicing or oiling
and still going strong!

Air-Marine Motors go to sea on USS Seawolf, Navy's newest atomic-powered submarine.

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When the U.S. Navy's atomic-powered submarine—miracle of modern engineering — churns through the waters at 50 fathoms down, its vital electronic equipment is constantly protected day and night by a battery of the most rugged blowers ever devised.

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Tough project? Not at all for Air-Marine. It's highly trained staff of engineers pooled their knowledge and promptly designed, to rigid Navy specifications, blowers that could run continuously toward a 10,000 hour life — more than a solid year — delivering uninterrupted cooling for the A-sub's vital installations.

Whatever your problem — small or large — this same experienced engineering staff is yours to command. Contact Air-Marine for your motor needs — for the best motors skill can produce — the finest money can buy.

115V 400CY 1PH 1.0MFD

Air-Marine's Seawolf Motor

air · marine motors, inc.
369 Bayview Avenue · Amityville, N. Y.
West Coast Factory: 2221 Barry Ave. · Los Angeles, Calif.

Above is an air-marine motors advertisement which first appeared in July, 1957.

Circle 575 on Page 19

of higher impedance. **Barber-Colman Co.**, Rockford, Ill. K

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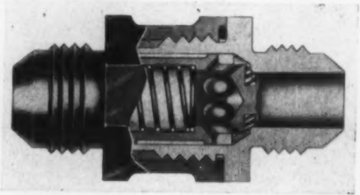
Relief Valve

provides forward flow with low pressure drop

In-line check or relief valve is used in hydraulic, fuel, cryogenic, and pneumatic systems, and is suitable for use in pressurizing fuel tanks. It provides forward flow with low pressure drop. Zero internal leakage is maintained against back pressure. In 1/2-in. line size, valve withstands pressures to 800 psi. Maximum pressure drop is 8 psi at 2400 lb per hr fuel flow. Valve operates at temperatures from −350 to +350 F. It can be modified for use as a pressure-relief valve to maintain cracking pressure ±10 per cent up to 3000 psi in 1/8-in. line size. Valve can also be modified as a check valve for operating pressures and reverse pressure differentials to 5000 psi and for temperatures to 1000 F. **Aero Supply Mfg. Co. Inc.**, Corry, Pa. F



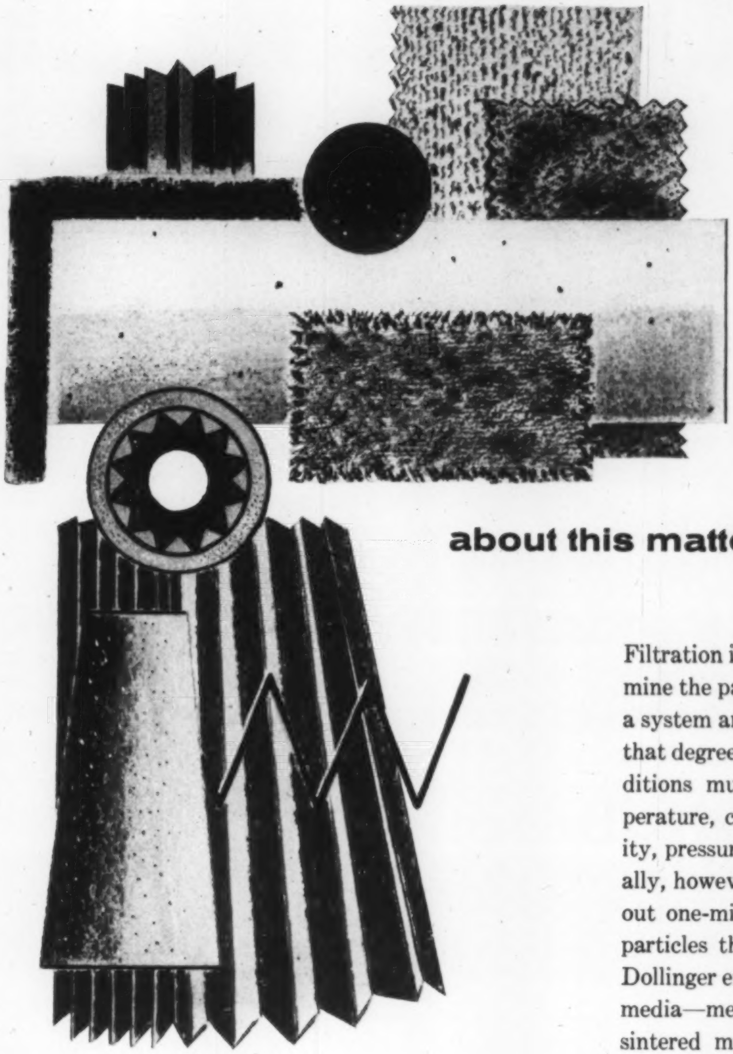
Circle 820 on Page 19

Subminiature Switch

withstands temperatures to 700 F

Measuring only 3/4 x 45/64 x 23/64 in., No. 61151 switch incorporates special refractory materials which ensure stability of operating characteristics over temperature range of −65 to +700 F. Life at rated load is 25,000 cycles at 700 F and 100,000 cycles at 450 F. Operating force is 10 to 20 oz. Electrical ratings is 5 amp resistive, 3 amp inductive, at 28 v dc. Nonsealed unit meets MIL-S-6743 and vibration requirements of MIL-E-5272A, Procedure II. **Haydon Switch Inc.**, 536 S. Leonard St., Waterbury 20, Conn. B

Circle 821 on Page 19



about this matter of filter media...

Filtration is all a matter of *degree*. You determine the particle size that can be tolerated in a system and then use a medium which gives that degree of filtration. Of course, other conditions must also be considered, i.e. temperature, corrosiveness, rate of flow, viscosity, pressure, allowable pressure drop. Basically, however, it's whether you want to filter out one-micron particles or strain one-inch particles that first determines the medium. Dollinger engineers make use of 110 standard media—mesh, woven cloth, felt, porous glass, sintered metals, paper, activated charcoal, etc. From this vast array, the most practical and economical medium can be selected and engineered into a unit which will meet all your filtration requirements.

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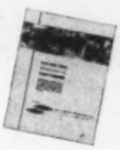

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Circle 576 on Page 19

FEED PARTS
TO GAST VACUUM PUMP
VACUUM CUP
PART TO BE PICKED UP, POSITIONED OR MOVED
PRESSURIZING
CONDUIT KEEPS CABLE DRY
TV TRANSMISSION CABLE
AIR FROM GAST COMPRESSOR
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GAST ROTARY

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- COMPRESSORS TO 30 P.S.I.
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"Air may be your answer!"

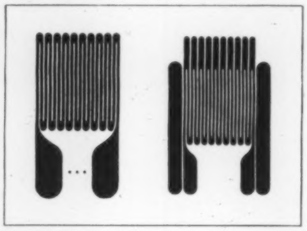
Circle 577 on Page 19

ENGINEERING DEPARTMENT EQUIPMENT

Strain Gages

for use on
magnesium parts

Principal applications of C15 strain gages are in the airframe and guided missile industries. Gages are used to stress-analyze structures such as fuselages, wing components, stabilizing fins, and missile bodies. Units provide an extremely low coefficient of resistance when mounted on such material as magnesium which has thermal expansion coefficient of approximately 15 parts per million per deg F. Two classes are available: Series 101 epoxy-black type (left) for use at temperatures from subzero to about 200 F; Series 100 strippable-type gages (right) for use at temperatures to about 500 F. Series 101 units are extremely flexible and accurate. Series 100 units have low apparent strain to 350 F, at which point it begins to increase. Three sizes are available in each series. Strain Gage & Transducer Dept., Tatnall Measuring Systems Co., Box 245, Phoenixville, Pa. E

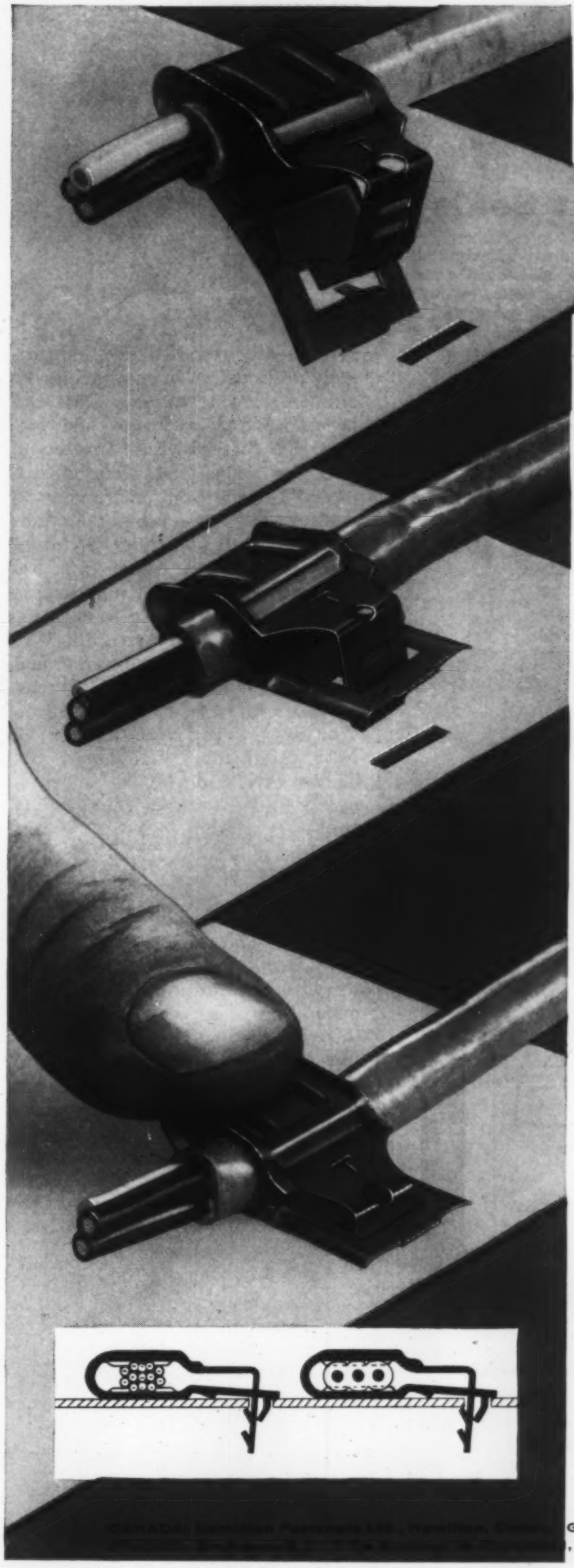


Circle 822 on Page 19

Recording Unit

puts physical variables
into visual form

Datascope is a recording-projecting oscillograph which puts into permanent, immediate visual form any type of physical variable—electrical, optical, acoustical, chemical, or thermal. Transient phenomena ranging from dc to 5000 cps are



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Ask your Tinnerman sales representative for samples and prices. He's listed under "Fasteners" in most Yellow Pages. Or write to:

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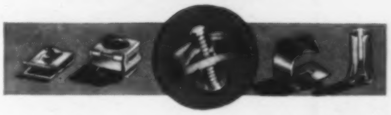

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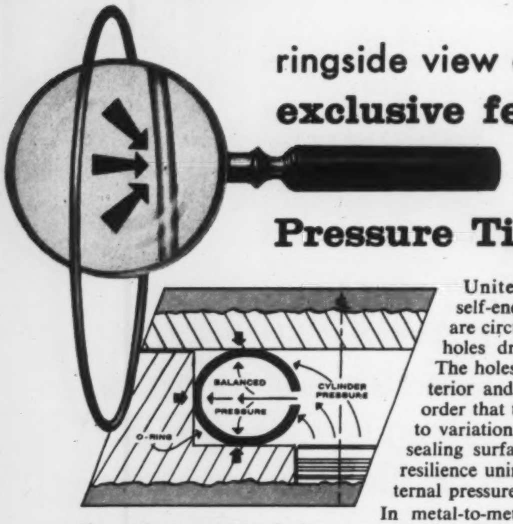

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United's exclusive, patented* self-energized metallic O-rings are circular tubes vented by tiny holes drilled in the ring wall. The holes are to balance the interior and exterior pressures in order that the ring may respond to variation in deflection of the sealing surfaces with a natural resilience uninhibited by the external pressure.

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PATENTS 2,809,269; *2,837,360

UNITED METALLIC "O" RING CORP.
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Division of United Aircraft Products, Inc.

Circle 579 on Page 19

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Here is a no cost, file size, 8½ x 11—8 page manual that gives you information that will help you plan the lubricating system of any type machine—from a one cylinder engine to a battle ship. It covers new and long recognized aspects related to the economics of engine and machine operations. Your copy will be sent promptly. Write —today.

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AT NO COST or obligation, send me the above manual

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Company ....

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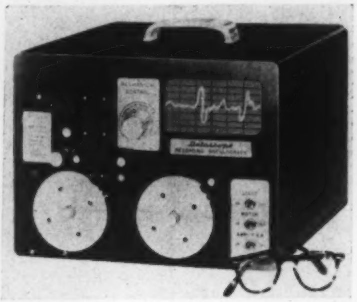

permanently recorded and immediately projected as an enlarged image on 4-in. viewing screen. Data can be transported backward and forward for detailed visual inspection. Recorded wave forms can be projected directly from instrument to wall screen, or important sections can be extracted as slides for future study. Full-sized image can also be preserved as a direct photograph. Magnetic memory unit, soon available, will permit recording of transients of very short duration and higher frequencies to 200,000 cps. Unit is 9 in. high, 12 in. wide, 8 in. deep, and weighs less than 15 lb. **Microsound Inc.**, 4627 Leahy St., Culver City, Calif. L

Circle 823 on Page 19

X-Y Recorders

are transistorized, modular units

New recorder consists of basic plotter with separate input modules for general-purpose, computer, low-level differential, time base, curve following, and other specialized functions. A totally transistorized unit, it has been improved to provide faster slewing speeds, 0.05 per cent internal calibration, 10 mv sensitivity, high-precision internal Zener diode reference, and vernier control be-

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with an interest in writing

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We're looking for several men with engineering experience and a yearning to write or edit. As an editor on MACHINE DESIGN, you would broaden your engineering background in a job that provides stimulating contact with people in many engineering areas.

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If you've worked in a design-engineering specialty area, we'd like to hear about it. We're interested in any job experience or training in:

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- Design for manufacture or production design

Our headquarters are in Cleveland. There is opportunity for travel to engineering meetings, expositions, and manufacturing companies. Salary will depend on your background and experience.

If you are interested, send a resume of your engineering background, and any evidence you may have of writing ability (we'll return this if you wish) to: Editor, MACHINE DESIGN, Penton Bldg., Cleveland 13, Ohio.

MACHINE DESIGN

NYLATRON® GS NYLON

Selection of NYLATRON GS nylon for critical automatic screw machine application (right) again proves its value as an outstanding material for today's designers.

Unique mechanical properties of NYLATRON GS nylon solve vital problems for industrial designers

• A leading manufacturer of automatic screw machines needed a material for use as a seal, which is spring loaded between the spindle and bearing retaining nut. After testing, the design engineers selected NYLATRON GS nylon for these reasons:

NYLATRON GS nylon is tough without being brittle. It formed a positive seal and provided longer wear. NYLATRON GS washers were economically machined to close tolerances from bar stock, provided uniform concentricity and an exacting fit.

The unique characteristics of NYLATRON GS are the result of a special formulation: a molybdenum disulphide filled nylon*, particularly adaptable as a material for bearings, bushings, liners and other parts subjected to extreme wear. Note these improved mechanical characteristics:

★ Greater Rigidity—higher modulus of elasticity, less deformation under load.
★ Higher Heat Distortion Temperatures—distortion temperatures 70% higher than nylon 101.
★ Lower Thermal Expansion—coefficient less than 65% of nylon 101.
★ Lower Surface Friction—can be used without lubrication.
★ Greater Wear and Abrasion Resistance—can outlast, outperform metal.

Stock shapes of NYLATRON GS include rod, strip, tubing, tubular bar and plate in all standard sizes—for rapid, low-cost fabrication on standard metalworking tools. In addition, it is available in powder form for molding.

Polymer can also supply stock shapes of all commercial nylons on request.

Write today for new booklet on NYLATRON GS—or other nylon formulations to meet your specific requirements.

Visit our booth No. 315
Design Engineering Show, Philadelphia
May 25 to 28

*Patented for composition and use for machine parts

THE POLYMER CORPORATION OF PENNA.
Reading, Pennsylvania
Export: Polypenco, Inc., Reading, Pa., U.S.A.

POLYPENCO®

Circle 581 on Page 19

tween ranges. Other improvements include remote operation of function modules, visible ink supply, front panel gain control, and calibrated scales on both axes. **Electro Instruments Inc.**, 3540 Aero Court, San Diego 11, Calif. L

Circle 824 on Page 19

Transistorized Power Supply

is fuseless, transient-free unit

No. MTR636-15 power supply is a 6 to 36-v dc at 15 amp unit. The transient-free supply is especially designed for testing transistorized circuits where transistor failure occurs with conventional statically regulated power supplies due to line and load transients. Unit has regulation of ±25 mv, ripple of 5 mv maximum, and dynamic impedance of 50 milliohms maximum from 0 to 20 kc. Automatic current-limiting circuit, which provides overload and short-circuit protection automatically, requires no output fuses. **Perkin Engineering Corp.**, 345 Kansas St., El Segundo, Calif. L

Circle 825 on Page 19

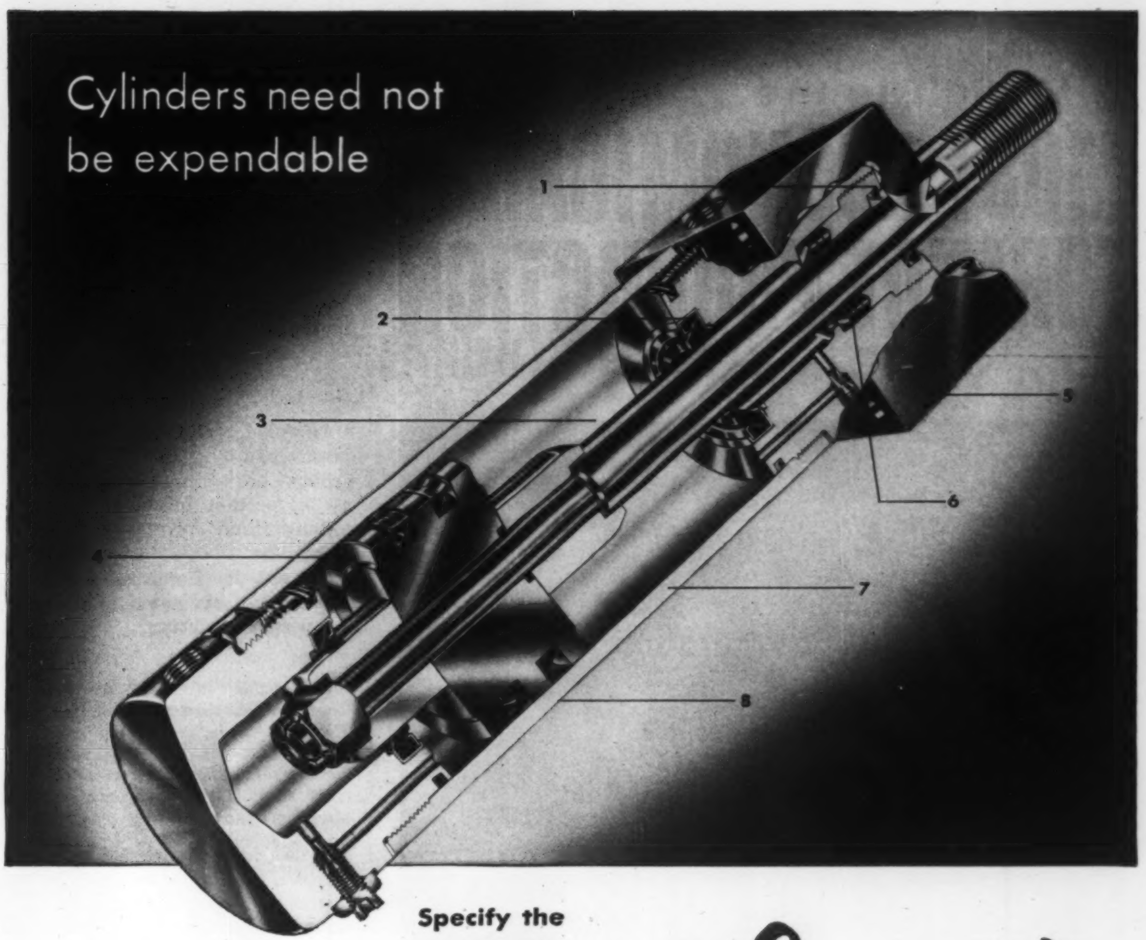
Preprinted Drafting Symbols

now furnished with two self-adhesive backings

Triacetate preprinted drafting symbols are available with a rubber and a resin-base adhesive. Either can be used where tracing cloth is employed. Resin-base adhesive does not leach out the oils in tracing papers and cannot cause ghosting. Rubber-base symbols are recommended for tracing papers which do not contain oils. Material is preprinted with symbols and coated with adhesive on either front or back. **Stanpat Co.**, Whitestone 57, N. Y. D

Circle 826 on Page 19

Cylinders need not be expendable



Specify the

T-J Spacemaker

for longer, more efficient cylinder service

With Extras . . . At No Extra Cost

1. METAL PISTON ROD SCRAPER—protects rod packing, cylinder bore and rod surface by removing all foreign particles.
2. NEW "SUPER" CUSHION for air or METALLIC SELF-ALIGNING MASTER CUSHION for oil.
3. HARD CHROME PLATED CYLINDER BORES AND PISTON RODS for greater protection and reduced wear.
4. ONE PIECE PISTON assures better alignment, longer bearing and packing life.
5. FORGED SOLID STEEL HEADS throughout entire line.
6. PILOTED PACKING GLAND with extra long bearing for additional strength and support to piston rod.
7. NO TIE-RODS TO STRETCH—gives you 360° port rotation . . . less space used . . . full strength.
8. STREAMLINED DESIGN . . . operating pressures to 200 PSI, air; 1,000 PSI oil, non-shock.

You too—can reduce replacement expenditures—lower maintenance costs with the T-J Spacemaker cylinder line. Designed and engineered for ruggedness, and accuracy of operation, the Spacemaker assures longer, uninterrupted operation.

The T-J Spacemaker eliminates tie-rods, gives greater strength, saves space . . . and reduces costs in all push-pull operations. Immediate delivery in a complete range of styles and capacities . . . air or oil. Write for Bulletin SM 155-4, today. The Tomkins-Johnson Company, Jackson, Michigan.

T-J
TOMKINS-JOHNSON
RIVITORS AIR AND HYDRAULIC CYLINDERS CUTTERS CLINCHORS

AMPCO ®

Which is the

MOST ECONOMICAL FORM OF PRODUCTION

for your design?

SAND CASTINGS?
CENTRIFUGAL CASTINGS?
EXTRUSIONS?
SHELL MOLDS?
FABRICATIONS?
ROLLED SHEET and PLATE?

* *Ampco's one-source service will provide finished parts to your specifications.*

You can get them all in an

AMPCO METAL

Your Ampco field engineer is not limited to a single copper-base alloy or a single form, in making recommendations. He can be completely impartial, because Ampco supplies them all.

He helps you realize savings that are often substantial, by making best use of (1) Ampco's metallurgical know-how; (2) Ampco's extensive mechanical and production facilities; (3) new techniques and equipment developed through Ampco research.

Call in your Ampco field engineer. Write for bulletin.

G-21

AMPCO METAL, INC., Dept. 30D, Milwaukee 46, Wis.
WEST COAST PLANT: BURBANK, CALIFORNIA • SOUTHWEST PLANT: GARLAND (DALLAS COUNTY), TEXAS

THE ENGINEER'S Library

Recent Books

Engineering and Technical Conventions, 1959-1964. 29 *pages,* 8¼ *by* 10⅞ *in., paperbound, stapled; available from Industrial Relations News,* 230 *West* 41st *St., New York* 36, *N. Y.;* $4.00 *per copy.*

National, regional, and state meetings of more than 100 technical groups are chronologically listed giving location, headquarters, meeting title, and sponsoring organization. An alphabetical list of the organizations contains their addresses and the name and title of the person to contact.

Introduction to Stress Analysis. *By Charles O. Harris, head, Dept. of Applied Mechanics, Michigan State University;* 330 *pages,* 6 *by* 9¼ *in., clothbound; published by The Macmillan Co.,* 60 *Fifth Ave., New York* 11, *N. Y.; available from* MACHINE DESIGN, $7.50 *per copy postpaid.*

Broad subject coverage with emphasis on theory is featured in this textbook. Stress resultants in bars serves as a review of statics. Thermal expansion is included in the discussion of uniform stresses. Torsion and shear flow, flexure and deformation, fatigue, creep, and relaxation are covered.

Shear stress in beams is followed with a presentation of shear and moment diagrams. Buckling of slender bars under compression is presented separately. Simple problems help introduce the subject of stress in plates and shells.

Chambers's Technical Dictionary. *Edited by C. F. Tweney and L. E. C. Hughes;* 1028 *pages,* 5½ *by* 8¼ *in., clothbound; printed in Great Britain; distributed by The Macmillan Co.,* 60 *Fifth Ave., New York* 11, *N. Y.; available from* MACHINE DESIGN, $7.50 *per copy postpaid.*

New terms in this third revised edition are used in aeronautics, chemistry, electronics, astronomy, and nuclear physics. Structural formulas are given for chemical substances, and recent discoveries re-

Circle 583 on Page 19

TEAR OUT AND PUNCH AS INDICATED FOR YOUR FILE

TEAR OUT AND PUNCH AS INDICATED FOR YOUR FILE

One in a series of technical reports by Bower

BEARING BRIEFINGS

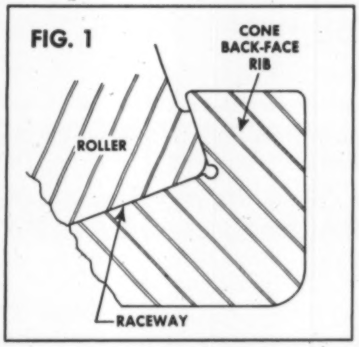
BEARING GEOMETRY
MAKES OR BREAKS BEARING PERFORMANCE

To develop high capacity and optimum performance in a tapered roller bearing, it is essential that roller alignment be accurate. Correct roller alignment, in turn, depends on a critical geometric relationship between the cone back-face rib, and the cone raceway.

Perfection in this geometric relationship compels the rollers to align themselves perfectly with respect to the bearing geometry, and each roller shares equally in the work that is imposed. Figure 1 diagrams the important elements involved.

When this rib-to-raceway relationship is incorrect (because of either faulty bearing design or manufacturing inaccuracies), rollers experience misalignment and begin to skid and skew under load. As engineers know, poor performance and premature bearing failure are inevitable under these conditions.

FIG. 1



In the design and manufacture of Bower tapered roller bearings, Bower engineers take great care to generate and hold an exact face angle on the cone back-face rib. In practice, this means that Bower bearings are designed for maximum life and optimum performance under any operating conditions. It means that Bower bearings retain accurate roller alignment under all speeds and loads up to the maximum for which the bearing is rated.

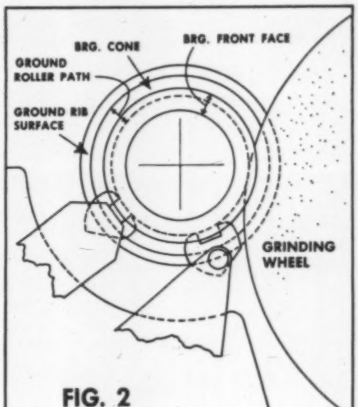
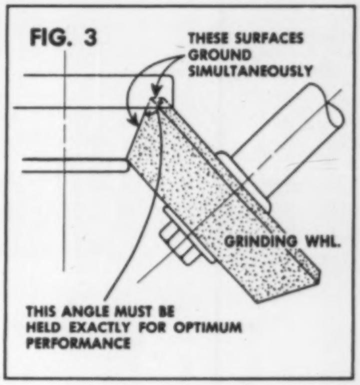


FIG. 2
FRONT VIEW

It's one thing to develop proper bearing design on paper, but quite another to carry it out consistently in manufacture. To this end, Bower engineers were instrumental in the design and development of a unique centerless grinder on which Bower precision grinds each bearing's cone raceway and rib-face simultaneously. The results obtained from these machines invariably meet or surpass Bower's exacting requirements and assure perfect roller alignment.

Figures 2 and 3 are front and side views which illustrate Bower's technique of centerless grinding rib-faces and cone raceways together. As a result, every component in a Bower bearing is perfectly concentric about its rolling axis.

FIG. 3

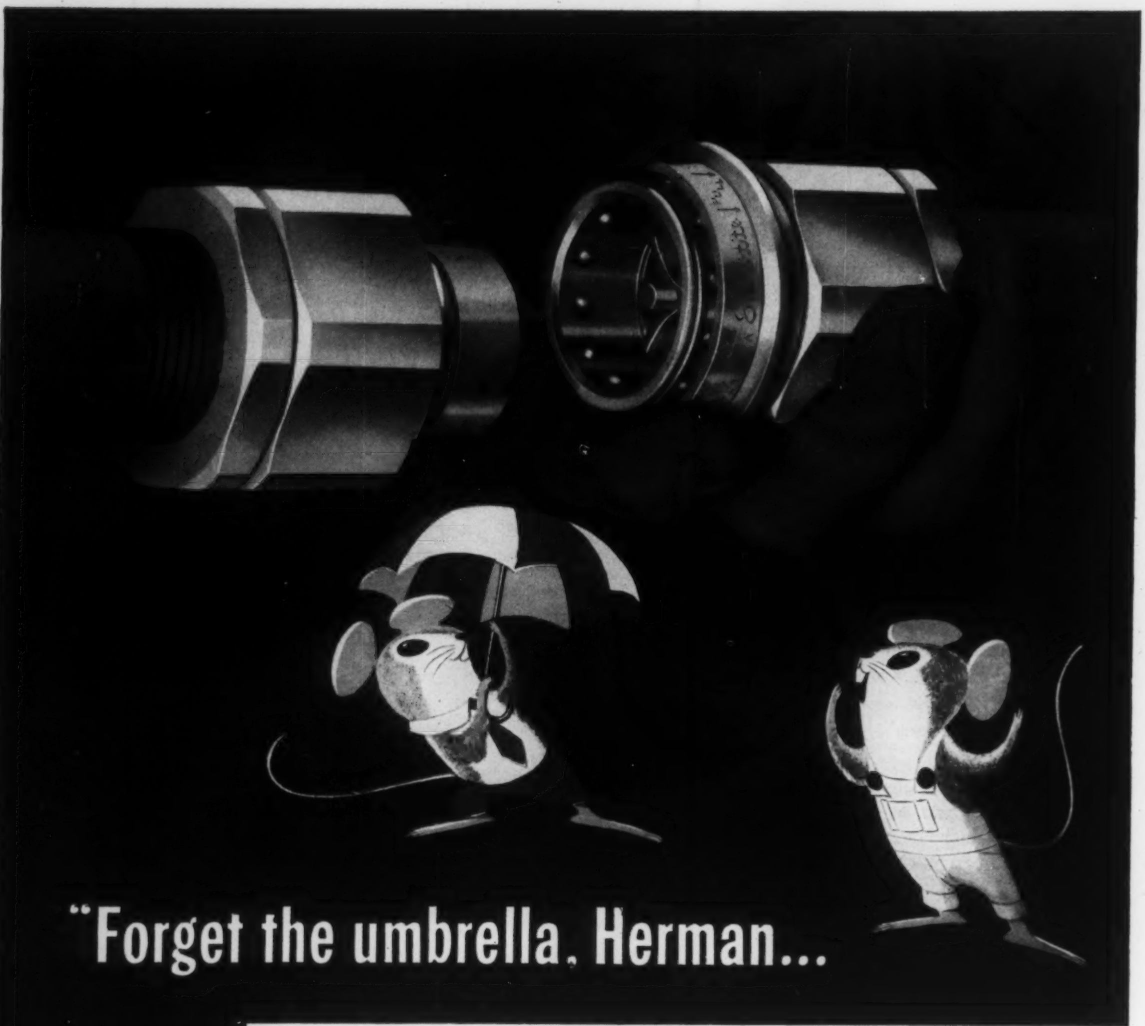

THESE SURFACES GROUND SIMULTANEOUSLY
GRINDING WHL.
THIS ANGLE MUST BE HELD EXACTLY FOR OPTIMUM PERFORMANCE

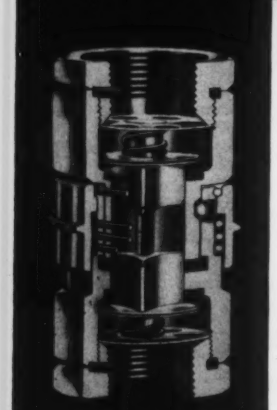
* * * *

When you require bearings, we suggest you consider the advantages of Bower bearings. Where product design calls for tapered or cylindrical roller bearings or journal roller assemblies, Bower can provide them in a full range of types and sizes. Bower engineers are always available, should you desire assistance or advice on bearing applications.

BOWER ROLLER BEARINGS

BOWER ROLLER BEARING DIVISION – FEDERAL-MOGUL-BOWER BEARINGS, INC., DETROIT 14, MICHIGAN


"Forget the umbrella, Herman...


Provided with valves to give two-way or one way automatic line shut off.

Built to handle high pressure hydraulic and pneumatic systems

Snap-Tite *valved* couplings stop flow instantly"

Snap-Tite provides instant shut-off wherever fluid coupling is needed.

Snap-Tite *valved* couplings connect and disconnect quickly and fully—they automatically open line flow when connected; positively seal your line when disconnected—with no "ifs," no chance for human error.

Snap-Tite couplings are available in sizes from ¼″ to 6″ ID, in steel, brass, aluminum, 303 ss and 316 ss. Sizes from 6″ to 10″ ID are available on special order. For more information, write for Snap-Tite catalog #58. Snap-Tite representatives are located in all principal cities.

SNAP-TITE COUPLINGS CAN HANDLE ALMOST ANYTHING THAT FLOWS

★Snap-Tite

ST-59-01

SNAP-TITE, INC. • UNION CITY 11, PA.

Circle 585 on Page 19

garding chemical elements appear in the tables. Entries cover more than 100 scientific and industrial activities.

Electromechanical Energy Conversion. *By David C. White, professor of electrical engineering, and Herbert H. Woodson, assistant professor of electrical engineering, both of Massachusetts Institute of Technology; 646 pages, 5¾ by 9 in., clothbound; published by John Wiley & Sons Inc., 440 Fourth Ave., New York 16, N. Y.; available from* MACHINE DESIGN, $12.50 *per copy postpaid.*

Scientific fundamentals are stressed as the basis for understanding reactions between electromagnetic fields and rotating equipment. After deriving equations of motion for analyzing typical motors and generators, the authors illustrate mathematical methods, from differential equations to analog computers, that can be used to solve the equations.

Development of one basic machine with one set of equations permits a unique approach to other machines. Subsequent analysis of commutator, induction, and synchronous machines demonstrates how changes in variables can adapt the basic method to various types of energy converters.

Lubrication Science and Technology, Vol. 1, No. 2. *Edited by John Boyd; 113 pages, 8¼ by 11¼ in., clothbound; published by Pergamon Press Inc., 122 East 55th St., New York 22, N. Y.; available from* MACHINE DESIGN, $10.00 *per copy postpaid.*

Sixteen papers are contained in this section of the transactions of the American Society of Lubrication Engineers. Subjects include lubrication of thrust ball bearings, ball-bearing fatigue life, cam and tappet lubrication, boundary lubrication, and hydrostatic bearings. Other papers discuss synthetic sapphire as a bearing material, ceramic versus carbide cutting tools, wear particles and adhesive wear at high contact pressures, and wear of nickel-base alloys and stainless materials.

Association Publications

Digest of Literature on Dielectrics, Vol. XXI-1957. *Edited by John Hart and Robert A. Soderman; 283 pages, 8½ by 11 in.,*

Circle 586 on Page 19→

Better Cleaning means Better Socket Screws for You

from **ALLEN**

These new industrial washing machines wash every Allen product — after each processing operation, and before heat treating — to remove all abrasives and contaminants. After washing, a vibrating de-chipper (shown in the foreground) removes metal particles that may adhere to products in process.

These are among the great many special features in Allen's new plant that assure you of constantly higher quality in socket screws. More than ever, you'll find that ALLEN is the "Buy-Word" for socket screws, as well as keys, dowel pins, and pipe plugs.

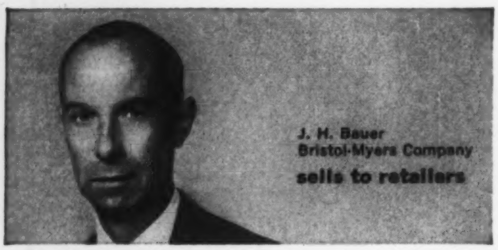
The scientific design of the cup diameter on ALLENPOINT Set Screws gives greatly increased resistance to *withdrawal* torque. You can count on Allenpoints to stay tighter longer, under heavy strain and vibrations. This dependable performance is yours to use at no premium in cost. Available in a full range of standard sizes from No. 0 thru 1". For samples and more information, ask your Industrial Distributor, or write direct to The Allen Manufacturing Company, Hartford 1, Connecticut.

ALLEN HEX-SOCKET SCREWS HEAD

Does specialized business publication advertising help salesmen?

No one is in a better position to give a hard-boiled, practical answer to this question than the men who spend their working lives on the sales front...the men the ads are supposed to help...the men who sell.

Here are the statements of salesmen who know what advertising does for them when it appears in the industrial, trade or professional publications that serve the specialized markets to which they sell:


J. H. Bauer
Bristol-Myers Company
sells to retailers

says Mr. Bauer: "My end of the business is primarily to do things for the retailers. So's the trade journal side of our advertising program.

"The consumer advertising gets people to go to the retailers and gives us good brand recognition and all that, but everything else we do in this company is to help the retailers move our products and make a profit.

"A big part of that is persuading them to get our brands out where they can be seen to meet the advertising effect.

"We have more than trebled the number of salesmen compared to what we had several years ago but our distribution has expanded so greatly that it's still hard to cover the trade.

"Thank goodness our company does a very stout trade advertising job for us. It supplements our heavy consumer advertising.

"It works too. It breaks the ice. No matter where I walk in to call on a wholesaler or retailer, I'm no stranger.

"I know that some companies in our field operate under the false assumption that consumer advertising can do it all.

"It can't.

"The consumer advertising can't talk about how we can help the retailer make money. You can't count on it alone to sell the executives of chains.

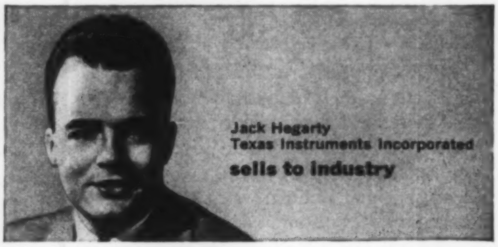
"Our trade advertising makes druggists, grocers and variety store people conscious of a new product, or a new promotion, or a new deal. Does it before I get there, too. It makes them anxious about it before I get there. It lets them know there's something big coming.

"Our advertising in the business papers also impresses retailers about the business they could lose if they let their stocks dwindle.

"Now, there's another side of our business paper advertising that has a very strong influence on my sales. I mean it really helps me. I'm talking about the advertising to professional people. That advertising does a lot to persuade nurses and doctors to recommend our products to patients under their care. Bufferin, for example. Naturally, it's wonderful for my end of the business if that advertising creates the impression with thousands of patients that our products have achieved professional recognition. I actually talk to retailers about what our company is doing to win the recognition of professional people and induce them to recommend our products.

"Incidentally, that is surely one area of business paper advertising where the consumer ads can't reach. Only in professional journals can you talk in detail of ingredients, for example, which can be a very important part of our sales story.

"It's pretty obvious that trade advertising which does all these things helps me sell."


Jack Hegarty
Texas Instruments Incorporated
sells to industry

says Mr. Hegarty: "I sell semiconductors and other components to original equipment manufacturers in the electronics field. With the tremendous expansion in the electronic industry today, one of our problems is prompt coverage of the market when a new or improved device is announced. I can contact all my larger accounts within a few days, but it takes considerable time to cover the many smaller accounts.

"That's one of the reasons I think our advertising in business publications is so important. It covers all my prospects, large and small, and gets the story of our products to all three groups that can influence purchases – the engineers, the purchasing agents and top management. In some accounts 50 or 60 engineers will attend a meeting. However, there are still many decision-making personnel who can't attend because of other demands on their time. But I know that they will get our story from our advertising.

"On cold calls, many times my selling effort is greatly assisted by the 'pre-selling' of our advertising and it seems to me that advertising often gets me an entree at a higher level than I can usually get on cold calls.

"It helps in other ways, too. For instance, we get inquiries for applications and devices that haven't been developed by our company. Prospects read the advertising, get clues, then contact us. In one case we ran an ad that basically showed a specification sheet on a new component. On one inquiry I followed up, the engineer had the magazine open on his desk right at our ad. He asked me, 'Can you meet this spec?' It was different – but, by some specialized design work, something we could do. I secured a first release order for over $70,000 just from this one inquiry.

"While my division of our corporation had first established its name in the industry on the basis of its work in semiconductors, we also manufacture many other components. They are in competition with units of companies longer established than we are. Here our advertising helps establish our name as a progressive company with a dependable reputation, good to deal with."

W. A. Beach
Black & Decker Mfg. Co.
sells to wholesalers and retailers

says Mr. Beach: "We have to sell our product first to the wholesaler; then help him sell to the retailer. We do a lot of missionary work. We make calls with the wholesaler salesmen and we run dealer and clerk training clinics in which we try to help the dealers improve their merchandising.

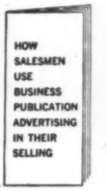
"Our trade advertising in publications read by the wholesaler and dealer, works with us along those same lines. In other words, it's like having an additional sales representative in each territory constantly calling on the dealers and wholesalers. Every time they open their trade books he tells them about our products and the special promotions we run to help them sell more. He works nights too, and calls on them at home when they're doing their reference work and planning. I know they do take their magazines home at night and read them. So, in effect, this 'salesman' works at night for us, and I do believe he finds them in a more receptive mood at that time.

"The greatest evidence that our advertising is out there doing a job and really paying off is in connection with the two large-scale promotions we do each year.

"For instance, right now we're working on our current Christmas promotion called 'The Bell-Ringer'. That was announced in September. Between the announcement and the Christmas selling season we must sell the wholesaler and then set up a schedule with each wholesaler to go out with his men and call on the trade and actually sell the deal to the retailer. You can imagine how tight our schedule is. In this short span of time we have to call on practically every hardware dealer in the territory. It adds up to a terrific number of calls and in order to get around, we just can't afford to give each dealer all the time we'd like to. In addition, it's extremely difficult to explain all the details on something like this Christmas promotion in the short time allotted each dealer.

"We couldn't do it if the advertising wasn't in there doing part of the work for us. Believe me, it's wonderful to find that when you do call on a wholesaler or dealer you don't have to take the time to explain all the details, because he has already read about it in the hardware publications. In most cases he's ready to see the merchandise. We have the opportunity to close the sale in short order. Right now I'm engaged in making dealer calls with wholesalers' salesmen and I'd say that nine cases out of ten the dealers have already seen our ads on the Christmas promotion and are somewhat pre-sold on the deal. In fact, in most cases I've found that all I have to do is show him the merchandise."

ask your own salesmen **what your company's business publication advertising does for them. If their answers are generally favorable, you can be sure that it is really helping them sell. If too many answers are negative, it could well pay you to review your advertising objectives—and to make sure the publications that carry your advertising are read by the men who must be sold.**


HOW
SALESMEN
USE
BUSINESS
PUBLICATION
ADVERTISING
IN THEIR
SELLING

Howsalesmen use their companies' advertising to get more business

Here's a useful package of ideas for the sales manager, advertising manager or agency man who would like to get more horsepower out of his advertising. Send for a free copy of the pocket size booklet which reports the successful methods employed by eleven salesmen who tell how they get more value out of their companies' business publication advertising.

You can be sure that more of your salesmen will use your advertising after they read how others get business through these simple methods.

The coupon is for your convenience in sending for your free copy.

National Business Publications, Inc.

NBP **...each of which serves a specialized market in a specific industry, trade or profession.**

NATIONAL BUSINESS PUBLICATIONS, INC.
Department 9C, 1413 K Street, N. W.
Washington 5, D. C. STerling 3-7533

Please send me a free copy of the NBP booklet "How Salesmen Use Business Publication Advertising in Their Selling."

Name

Title

Company

Street Address

City Zone State

Chace THERMOSTATIC BIMETAL ACTUATES ANOTHER PRECISION PRODUCT

A product of
The Wilcolator Co.
Elizabeth, N. J.

The Wilcolator TYPE L THERMOSTAT

The modern home employs literally scores of electric and gas-heated appliances, such as space heaters, clothes dryers, air conditioners, furnaces. And any one of these might be a hazard were it not for dependable thermostats such as this new Type L, manufactured by The Wilcolator Company. It is non-adjustable and factory calibrated to the customer's specification to open or close an electrical circuit when heated above its control set-point. Its dynamic response is unusually fast for a completely enclosed switch, comparable under certain conditions to the exposed element type. This thermostat is available in Regular (contacts normally closed) and Inverse (contacts normally open) within the range of 125° F. to 350° F. The actuating element is Chace Thermostatic Bimetal.

If all the homes in the world containing equipment protected by Chace Thermostatic Bimetal were lined up side by side, we're reasonably sure you'd have a Main Street reaching around the globe. We're proud that Wilcolator recognizes the Chace contribution to the safety and dependability of these millions of appliances, joining the hundreds of manufacturers who have benefited from Chace's precision methods in our third of a century of thermostatic bimetal production. Chace's creed: "Uniformity, uniformity, uniformity" is Wilcolator's assurance that no appliance employing their product will fail in the performance of its duty.

Before your new temperature-actuated product reaches the designing board, send for our booklet "Successful Applications of Thermostatic Bimetal." You'll find its general information and engineering data extremely helpful, second only to consultation with our engineers. Remember, too, Chace Thermostatic Bimetal is available in over 30 standard types, in strip, rolls or completely fabricated elements of customer's design.

IT BENDS WITH THE HEAT
W. M. CHACE CO.
Thermostatic Bimetal
1616 BEARD AVE., DETROIT 9, MICH.

Circle 589 on Page 19

paperbound; published by and available from National Academy of Sciences, National Research Council, 2101 Constitution Ave., Washington, D. C.; $5.00 per copy.

Thirteen reports deal with various phases of materials structure and properties. Included with instrumentation and measurements is a table of dielectric constants and dipole moments. Dielectric theory, as well as a discussion of photoconduction and electroluminescence, is presented. Latest information and applications are reported for piezoelectric, ferroelectric, and ferromagnetic materials. Recent uses are also described for insulating films and liquids, and rubber, plastic, and ceramic insulation.

Plastic Design in Steel. *94 pages, 8½ by 11 in., clothbound; available from American Institute of Steel Construction, 101 Park Ave., New York 17, N. Y.; $4.00 per copy.*

Recommended working stresses based upon elastic analysis provide a reasonable index to actual strength of isolated structural members and their connections. However, for continuous steel structures with horizontal and gravity loading, design must be based on ultimate or plastic strength.

This method provides a uniform margin of safety, is less time-consuming, and permits a substantial savings in steel. Numerous reference charts and formulas are included for beams and frames.

Government Publications

OTS Technical Reports. *Copies are available from Office of Technical Services, U. S. Dept. of Commerce, Washington 25, D. C.*

The following reports are available:

PB 151243. Research on Ferrous Materials Fatigue. By Harold N. Cummings, Foster B. Stulen, and William C. Schulte, for WADC; 114 pages, 8¼ by 10¾ in., paperbound, stapled; $2.50 per copy.

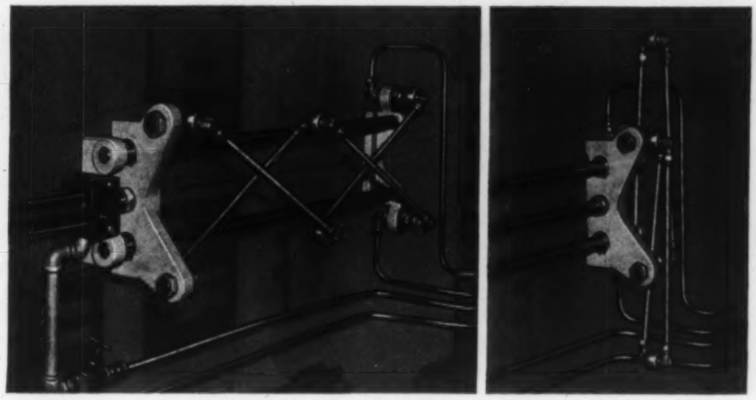
Statistical studies of laws of propagation of fatigue cracks in SAE 4340; investigation of fatigue properties of shot-peened cadmium-plated SAE 4340, of carburized AMS 6260, and of nitrided AMS 6470 and SAE 4340; investigation of transverse properties of rolled and of forged SAE 4340.

PB 151272. Development of Brazed Sandwich Construction Materials for High Temperature Applications. By Charles F. Burrows and F. J. Ragland Jr., for WADC; 105 pages, 8¼ by 10¾ in., paperbound, stapled; $2.50 per copy.

Skin and core materials selected were 17-7PH, 422, A-286, 19-9DL and 17-14 Cu Mo; sources listed for silver-base and nickel-base brazing alloys selected; includes mechanical and corrosion test data; 1200 F maximum test temperature.

IN EQUIPMENT DESIGN ■

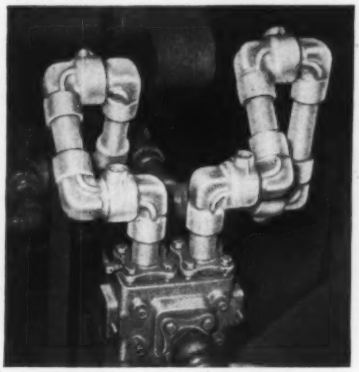
CHIKSAN SWIVEL JOINTS SMOOTH OUT KNOTTY LINE PROBLEMS



STEEL LINES FOLD LIKE AN ACCORDION

Connected to a moving head, these compact swivel jointed all-metal hydraulic lines flex and fold like an accordion on this automatic bottle unpacking machine.

When a machine's moving parts cause tight bend or twist on hose lines, Chiksan Swivel Joints provide a ready solution. When design dictates the use of metal lines, Chiksan Swivel Joints allow rubber-like flexibility. In fact, wherever line flexibility is required, designers and maintenance engineers know it's just good business to call on Chiksan. Precision made Chiksan Swivel Joints with their infinite service life, full 360° rotation and high safety factor, quickly pay for themselves by minimizing hose replacement and eliminating costly line failure, fluid loss and downtime. If your equipment hose lines require frequent replacement due to torsion or bend radii fatigue, or if flexible all metal lines are in order, contact Chiksan. A nearby representative will call, analyze your requirements, and make specific recommendations. Write today for his name.

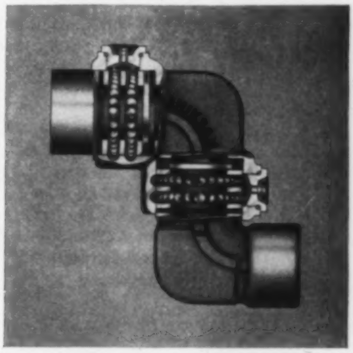


NO HOSE BURST HERE

These Chiksan swivel jointed steel lines on a die casting machine eliminate damaging hose ruptures, reduce fire hazard, fluid loss and setup time by 75%.

NO BEND FATIGUE HERE

This highly specialized lens grinder utilizes Chiksan Swivel Joints to eliminate tight hose bend as the multiposition head is shifted from one grinding position to another.



LOOK INSIDE A SWIVEL JOINT

Detailed attention to detail. Precision machining and specific packing seals for specific services. These are the quality-plus features built into every Chiksan Swivel Joint.

CHIKSAN

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CHIKSAN COMPANY—BREA, CALIFORNIA • CHICAGO 5, ILLINOIS • NEWARK 2, NEW JERSEY

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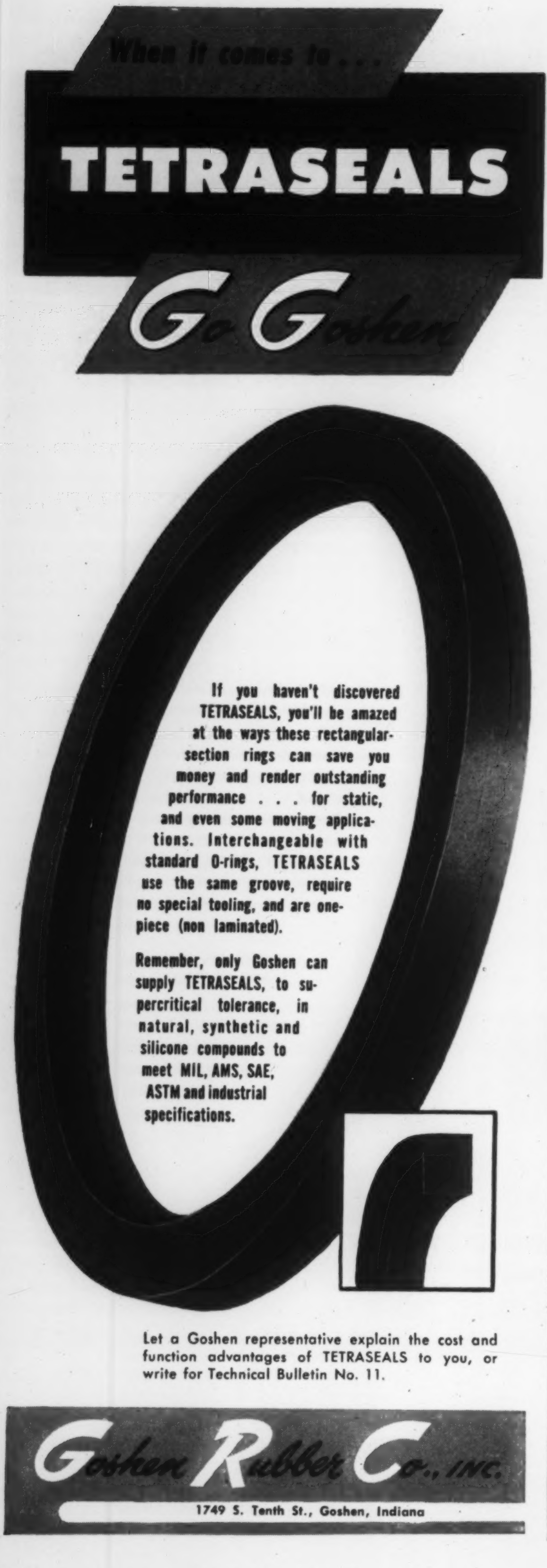
Circle 590 on Page 19



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If you haven't discovered TETRASEALS, you'll be amazed at the ways these rectangular-section rings can save you money and render outstanding performance . . . for static, and even some moving applications. Interchangeable with standard O-rings, TETRASEALS use the same groove, require no special tooling, and are one-piece (non laminated).

Remember, only Goshen can supply TETRASEALS, to supercritical tolerance, in natural, synthetic and silicone compounds to meet MIL, AMS, SAE, ASTM and industrial specifications.

Let a Goshen representative explain the cost and function advantages of TETRASEALS to you, or write for Technical Bulletin No. 11.

Goshen Rubber Co., INC.
1749 S. Tenth St., Goshen, Indiana

Professional Viewpoints

. . . designing an Army rifle . . .

To the Editor:

The article, "What's So Tough about Designing an Army Rifle?" (MACHINE DESIGN, February 19, 1959), outlines some of the difficulties facing the designer of semiautomatic firearms. It is understood that an article of a few pages cannot treat this problem thoroughly but some inaccuracies deserve mentioning.

Mr. Leach states that the Browning recoil action was the first automatic action where the breechblock remains locked during the critical firing phase. In 1883, Hiram Maxim showed a recoil loader with breech locked during the high-pressure period. It was the first fully automatic firearm using water cooling and cartridge-feeding by belt, a system still in use. To understand the greatness of this achievement, take into consideration that it was the time when attempts were being made to replace the tubular magazine below the barrel of Army rifles with a centrally located magazine, loaded by clips.

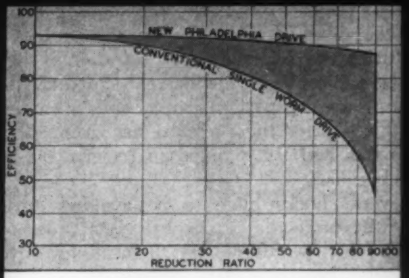
Ferdinand von Mannlicher, an Austrian, conceived the first practical solution. This most prolific pioneer of self-loading and automatic firearms and magazine-equipped military rifles disclosed the first light machine gun with swinging locking lever, short-recoil barrel, accelerator, central magazine, and rifle stock in the year 1885. At the same time the Austrian cavalry officer, Baron Odkolek, introduced the first full automatic gas piston loader, which was later manufactured by the French Hotchkiss Co.

The English patent of Hiram Maxim (1885) utilizes the force of gases issuing from the muzzle to operate the firearm. A sleeve is forced forward and produces the rearward movement of the parts of the breech mechanism. Other inventors also showed firearms with gas pistons, using gas trapped at the muzzle. It was not Garand's M-1 rifle which initiated this principle, as stated in Mr. Leach's article.

The counter-recoil spring of a blow-back rifle system cannot be strong, as it has to be cocked by hand after a misfire and for the first shot. Its influence in retarding the breechblock is so small in comparison with the influence of the inertia of the breechblock that it can be completely neglected in the first period of the breech movement. The spring tension is approximately only one thousandth of the accelerating force. During the travel of the bullet in the barrel, the momentum of the breechblock equals the combined momentum of the bullet and the half of the powder charge:

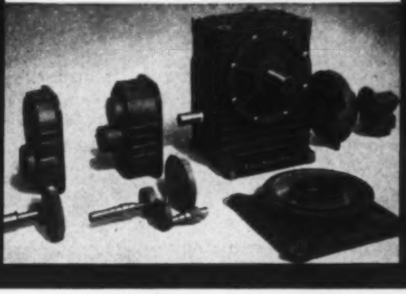
$$m_b v_b = m_p v_p + 0.5(m_c v_c)$$

where m stands for mass, v for velocity and the indexes b, p and c stand for breechblock, projectile, and charge. The tension of the recoil spring is completely negligible, even if more accurate formulas are used. The state-



Shaded area shows gain in power consumption.

New design standardization permits fast assembly and shipment from stock of any size and ratio with any mounting and drive arrangement.



NOW get new efficiency new savings in weight and space in worm gear drives

New high efficiency. These new drives offer efficiencies never before available in worm gear drives. Helical attachments for double and triple reduction units combine the efficiency advantage of helical gearing with the high ratio advantage of worm gearing. You save on power consumption . . . operating temperatures are lower . . . gearing lasts longer.

New high capacity. This is not just a re-rated line. Improved tooth forms, precision ground alloy steel worms, special high strength bronze gears, sturdy housings, precision ground helical gearing . . . all mean higher capacity in less space. In fact, you get space savings to 50% . . . weight savings to 60%. Or, you can handle loads up to 80% greater in the same space.

New flexibility. These new heavy duty high efficiency Philadelphia drives have a degree of flexibility never before available. One basic housing design can be combined with standardized horizontal and vertical mounting bases, worm gearing, single and double helical attachments, and fans, for any drive and mounting arrangement in the exact size and ratio to meet your requirements . . . standard or special. Torque control attachments for all sizes are available from stock for applications demanding overload protection. Ratios from 5⅛ : 1 to 1212 : 1. Center distances from 3″ to 21″. Write for catalog information.

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INDUSTRIAL GEARS & SPEED REDUCERS • LIMITORQUE VALVE CONTROLS • FLUID MIXERS • FLEXIBLE COUPLINGS

Circle 592 on Page 19

ment that the spring tension and inertia "are balanced in such a ratio that the bullet was just leaving the muzzle and the pressure had dropped to a safe level before breech opened to a significant degree" is therefore misleading. The spring tension is only important after the breechblock is fully accelerated, as the spring has to absorb most of the recoil energy of the breech and the other moving parts, and to store energy for completion of the firing cycle.

The main problem in designing a self-loading shoulder firearm for the heavy infantry cartridge is that the forces to operate the self-loading mechanism have to be diverted from the energy of the powder charge during the extremely short duration of the traveling of the projectile in the barrel. Further, the cartridge has to be supported firmly, and the energy has to be utilized after the pressure has dropped and the cartridge has had time to loosen its grip on the wall of the chamber.

All severe shocks have to be avoided during the travel of the projectile in the barrel in order to avoid vibrations which would destroy the accuracy of the rifle. Further, the breech usually moves backward in the loading cycle. It has to be protected by the receiver. This involves longer receivers, and if an ordinary rifle stock is used, the barrel has to be moved forward, the magazine also, resulting in a relatively heavier rifle and a change of balance.

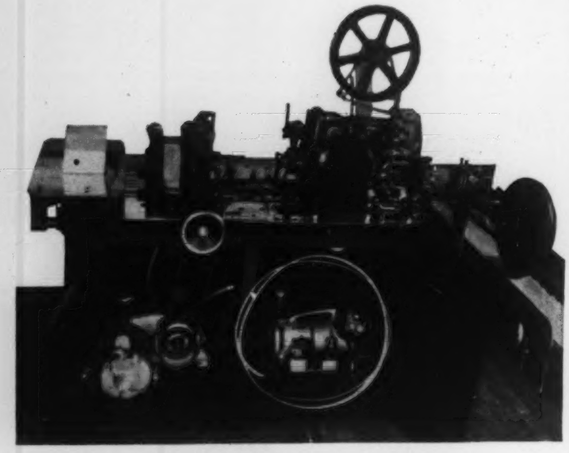
It is quite interesting to see that in the last 60 years no new conception in automatic firearm design has been found. On the contrary, new metallurgical and technological achievements made it possible to revive the old idea of the power-driven firearm, like the Gatling gun, for special purposes. All pioneer work was done more than half a century ago.

This fact in mind, it seems to me essential that the creative engineer learn to make use of the only comprehensive, historically correct, and up-to-date "textbook," the patents of important countries, filed according to classes and subclasses. This information should be available to every development engineer, fast, cheap, at his fingertips. Modern microfilming makes this possible. Then the patent would be what it was intended for and what it is in Continental countries: The teacher of the nation and not only a fence to establish short-lived monopolies.

Heinrich von Wimmersperg
Detroit, Mich.

They Say . . .

"Everyone is aware today that our educational system has been allowed to deteriorate. It has been going downhill for some years without anything really constructive having been done to arrest the decline, still less to reverse its course. We thus have a chronic crisis; an unsolved problem as grave as any that faces our country. Unless this problem is dealt with promptly and effectively the machinery which sustains our level of material prosperity and political power will begin to slow down."—Rear Adm. H. G. Rickover, *U. S. Atomic Energy Commission.*

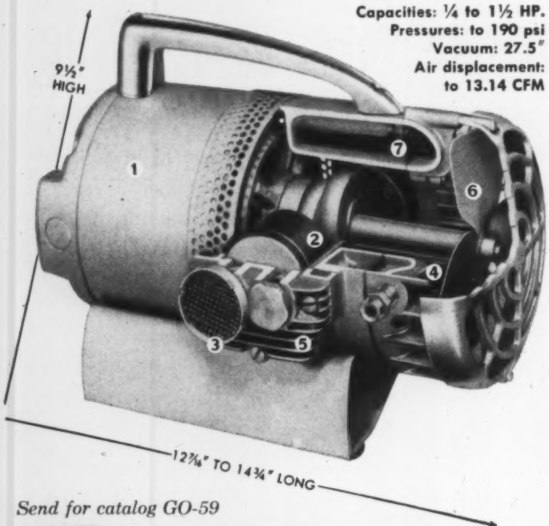


AIR-POWERED WITH *Oil-Free* AIR

The growing use of compressed air for trouble-free motive power is illustrated by this application of a B&G Oil-less Air Compressor to a mailing machine.

There is no chance of oil-spoiled work—*not a drop of oil* can be found in this compact, lightweight compressor. Motor and compressor are permanently grease-packed... carbon-graphite piston rings and skirts operate for years without injury to the cylinder walls. Since the cylinders are not lubricated, oil-free air is delivered at all times—no oil separator needed—no costly lubrication maintenance.

B&G Oil-less Compressors are *velvet-smooth!* Modern design, large bore, short stroke, horizontally opposed pistons provide better balance and vibrationless operation. B&G Compressors are available in a complete line of portable, tank mounted and tankless models.



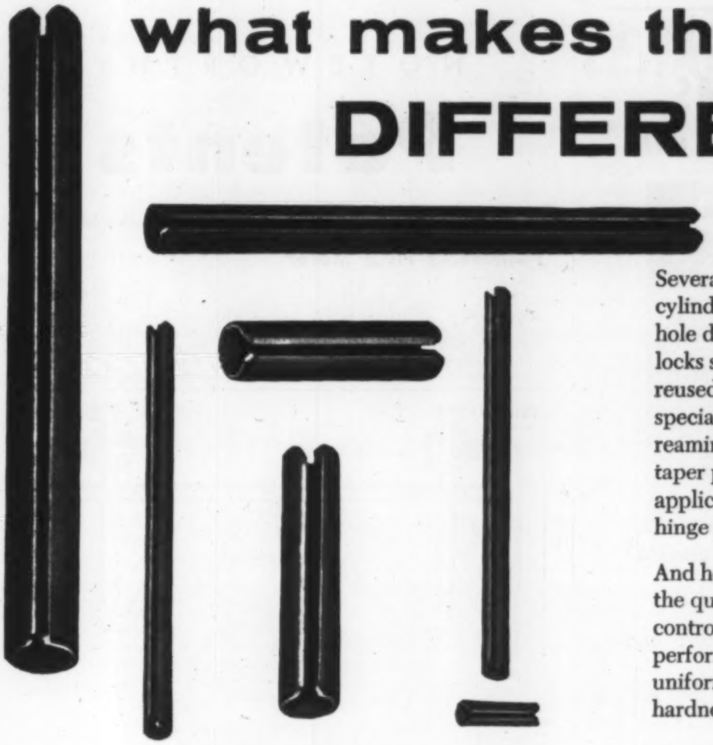
Send for catalog GO-59

B & G

Oil-less
AIR COMPRESSORS
BELL & GOSSETT COMPANY
Dept. FR-67, Morton Grove, Illinois

Circle 593 on Page 19

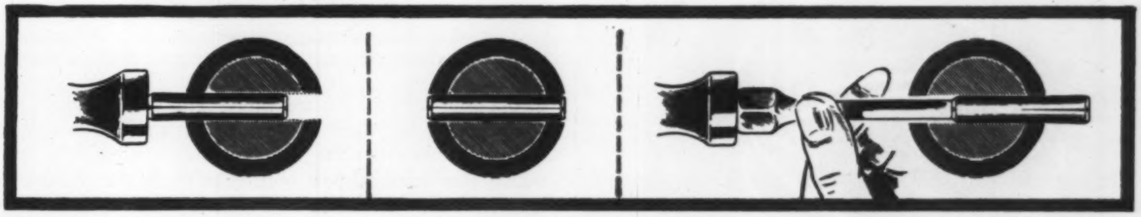
what makes this fastener DIFFERENT?



Several things. Rollpin® is a slotted, chamfered, cylindrical spring pin which drives easily into a hole drilled to normal production standards. It locks securely in place, yet can be drifted out and reused whenever necessary. This eliminates special machining, tapping, and the need for hole reaming or precision tolerances. Rollpin replaces taper pins, straight pins and set screws; for many applications it will serve as a rivet, dowel, hinge pin, cotter pin or stop pin.

And here's another difference that makes Rollpin the quality fastener in the field: ESNA's quality control builds consistent strength and performance into every Rollpin. Rollpin is uniform as to shear strength, dimensions, hardness, and insertion and removal forces

HOW YOU INSERT IT



Drives easily by hammer, arbor press, or air cylinder and can be readily adapted to an automatic hopper feed. Requires only a standard hole, drilled to normal production-line tolerances.

Locks securely in place without using a secondary locking device; won't loosen despite impact loading, stress reversals, or severe vibration.

Removes readily with a drift pin without damage to pin or hole, can be used again and again in original hole.

HOW YOU SAVE

You pay less for Rollpins than for most tapered, notched, grooved or dowel pins. Installation costs are substantially less than for any fastener requiring a precision fit or secondary locking operations.

Because of their tubular shape, Rollpins are lighter than solid pins. Production maintenance is reduced with Rollpins: they do not loosen and because of their spring action they tend to conform to the drilled hole in which they're inserted, without material hole wear, eliminating the necessity of re-drilling or using oversize pins.

MATERIALS AND SIZES

Standard Rollpins are made from carbon steel and Type 420 corrosion resistant steel. They're also available in beryllium copper for applications requiring exceptional resistance to corrosive attack, good electrical, anti-magnetic, and non-sparking properties. Stock sizes range from .062" to .500" in carbon and stainless steels.

ROLLPIN®

ELASTIC STOP NUT CORPORATION OF AMERICA

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Please send me the following free fastening information:

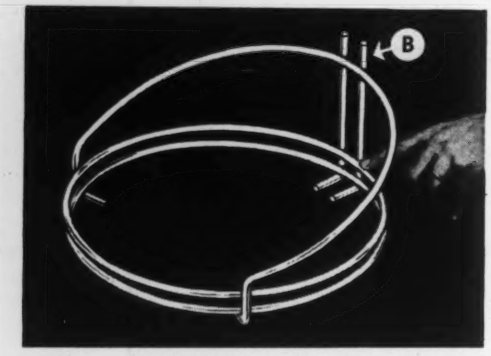
☐ Rollpin Bulletin
☐ Elastic Stop nut Bulletin
☐ Here is a drawing of our product. What self-locking fastener would you suggest?

Name ____________________ Title ____________
Firm ____________________
Street ____________________
City ____________________ Zone ______ State ______

HOW TITCHENER SOLVED 3 PROBLEMS,
and with a lower cost per unit

BEFORE . . . Milking machine can bracket* was made from arc-welded strip steel:

1. Bracket was heavy
2. Large surface areas collected dirt and bracket was hard to keep clean
3. Mounting sleeve, A, would fit only one size stanchion arm or post



AFTER . . . TITCHENER redesigned the bracket entirely of wire:

1. Bracket is much lighter
2. Smooth, round, lustre-zinc plated surface of the wire is easy to keep clean
3. Wire mounting bracket, B, easily fastened to any size post using standard hose clamps

RESULT . . . a much improved product, and with a much lower cost per unit!

Perhaps wire design can solve your problem with lower cost. Send us the actual part, blueprint or sketch; better yet, visit our plant . . . let us show you what we can do for you.

*Name of manufacturer on request

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E. H. Titchener & Co.
65 Clinton Street, Binghamton, N. Y.

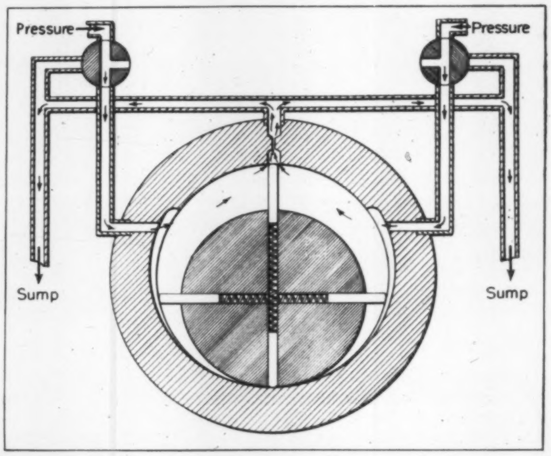
Circle 595 on Page 19

NOTEWORTHY

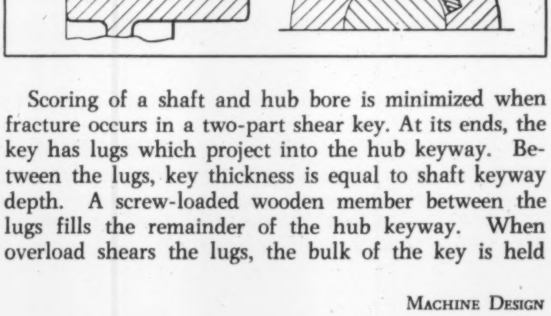
Patents

Positioning Fluid Motor

The rotor of a fluid motor can be held stationary, accurately aligned with an outlet orifice, when equal flow is delivered through valves in two lines leading to opposite sides of the assembly. The rotor blades are slightly thinner than the width of the outlet port. Hence, a vane nearest the port hunts a position in which flow is equal past both sides of its tip. Manipulation of the valves can also obtain accurate indexing in increments of 90 degrees. *Patent* 2,873,725 *assigned to International Business Machines Corp., New York, by Paul A. Gilovich.*



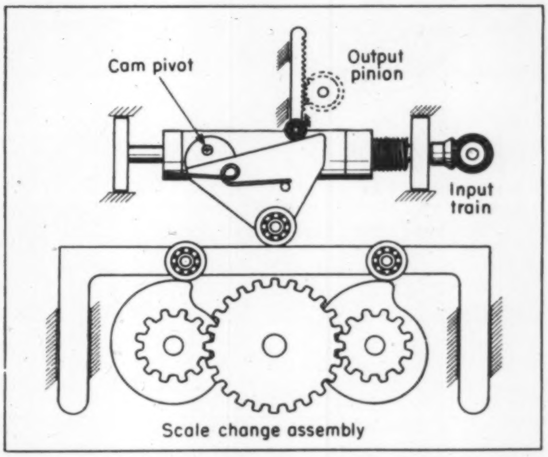
Overload-Release Key



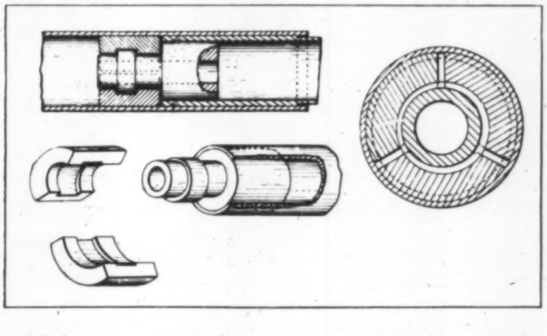
Scoring of a shaft and hub bore is minimized when fracture occurs in a two-part shear key. At its ends, the key has lugs which project into the hub keyway. Between the lugs, key thickness is equal to shaft keyway depth. A screw-loaded wooden member between the lugs fills the remainder of the hub keyway. When overload shears the lugs, the bulk of the key is held in the shaft by the wood which rides the shaft OD while the lugs float radially outward in the hub keyway. *Patent* 2,828,161 *assigned to the Jeffrey Mfg. Co., Columbus, Ohio, by Paul V. Whitney.*

Adjustable-Ratio Angular-Displacement Indicator

An angular displacement indicator includes means to adjust its output scale, that is, the ratio of input to output angular displacements. Input translates a leadscrew carriage to which a cam is fixed but free to pivot at a single point. An inclined plane on the cam enables conversion of linear carriage motion to linear rack motion. The rack drives an output indicator pinion. A roller on the cam travels a surface on a scale-change assembly. Adjustments of the distance from this surface to the lead-screw axis cause changes in the angle of the cam plane and, in turn, the output scale. *Patent* 2,875,622, *assigned to Collins Radio Co., Cedar Rapids, Iowa, by Donald E. Nichols.*



Quick-Release Telescoping-Tube Connection



Moderate turning about its own axis locks one tube telescoped in another. A tubular or rod-like member fixed to and projecting from the inner member has an integral, eccentric collar. The collar engages a number of circular ring sectors, all of which have eccentric channels corresponding to the collar. As the inner

LEAKPROOF (SHEAR-SEAL)

$75.00
List Price* for a ½" 4-way incl. Solenoid

*3-way, shut-off and smaller sizes are comparably less. All prices less the usual trade and quantity discounts.

SOLENOID OIL VALVES (250 P.S.I.)

WHERE	WHY	HOW
Thread rolling machines	Holding position (leakproof)	Lapped sealing surfaces seal tight indefinitely as a result of wear compensation
Pressure testing in automotive production	Oil gets contaminated by scale in castings (not critical to dirt) reduced maintenance	Sealing surfaces in constant, intimate contact, dirt can't lock valving members–saves coil burn-out
Hydraulic work feed apparatus	(Leakproof) . . . as versus spool valves which cause over-demand on hydraulic system	Positive shut off of internal port to port leakage and of course, no external leakage
Machine tool chucking & clamping	Maintaining safe holding pressure (leakproof)	Saving auxiliary equipment such as pilot operated check valves
Automatic door openers	Quick action (high flow capacity)	No spools or poppets obstructing full, round flow passages
Solenoid controlled hydraulic system on machine you build	Better performance Lower manufacturing costs Reduce service problems	Shear-Seal valves have full flow, are leakproof, not sensitive to dirt Low priced, less auxiliary equipment and labor cost. Valves don't stick, saving coil burn-out; stay leakproof indefinitely, seals are wear compensating

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CONTROL VALVE DIVISION
barksdale valves

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Circle 596 on Page 19

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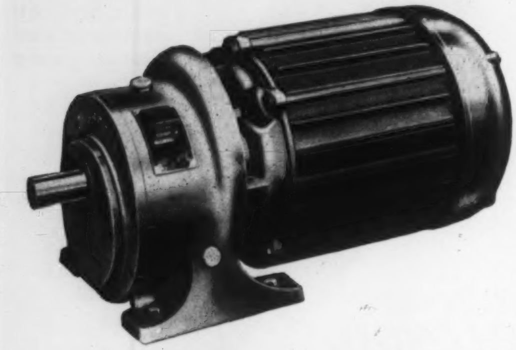
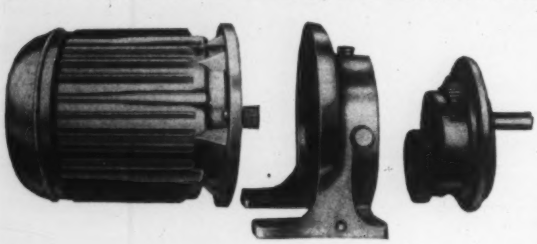


with the EXACT gear ratio TO MEET YOUR CUSTOMERS' REQUIREMENTS



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. . . to handle Crofts 'Ritespeed' gearmotors, the latest development in gear unit design. 'Ritespeed' Cartridge Series gearmotors consist of a cartridge assembly, gearcase and motor which form a complete unit when assembled together. This simplicity of design and its compact construction make it an easy matter to fit the cartridge assembly and motor with the correct high speed wheel and pinion to give the overall ratio required.

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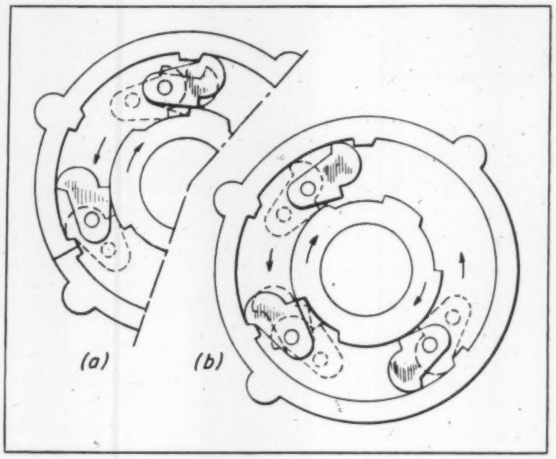
Rockwood Pulley Mfg. Co., 20 Crosby St., New York 13

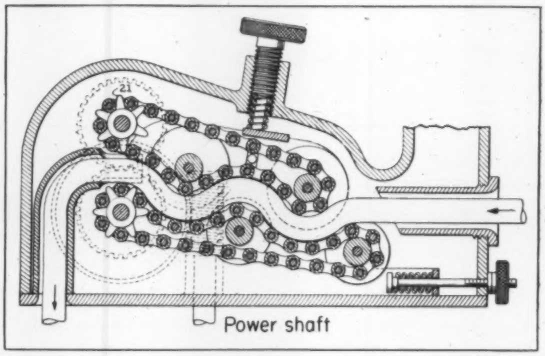
tube is turned relative to the outer tube, eccentric surfaces wedge the tubes together. *Patent* 2,873,129 *assigned to Tubelock Co. by Warren F. Edmundson.*

Intermittent-Motion Mechanism

Intermittent rotary motion, according to a desired pattern, is obtained from an assembly of round, concentric, plate cams. One of the cams is a stationary housing which has lugs projecting inward from its ID. The other, having a cam contour on its OD, is in the center of the assembly, and is driven clockwise at constant speed. Between the two, a plate is driven counterclockwise from an exterior power train which must include a clutch. Interruption of the rotation of this plate is assembly output. The plate carries a number of latching pawls free to swing on pins. In operation, the center cam forces successive pawls against the case lugs, then provides clearance for the plate to cam the pawls off the lugs. *Patent* 2,876,868 *assigned to the United States of America (Army) by Henry N. Nerwin.*



Roller-Chain Traction Drive



Two recirculating link chains form a serpentine channel which supplements the traction of the chains themselves in pulling or drawing linear materials such as chain, rope, hose, and flexible rod or tube stock. Each chain has a sprocket, which is powered, and two

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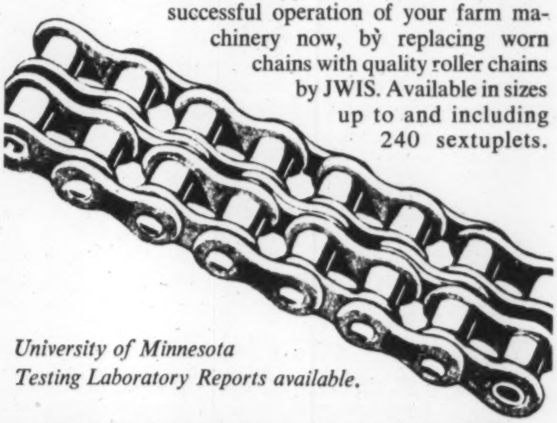
Manufactured by highly skilled technicians in West Germany, JWIS Roller Chains are now available in all sizes and types, from stock. Insure the successful operation of your farm machinery now, by replacing worn chains with quality roller chains by JWIS. Available in sizes up to and including 240 sextuplets.



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"Monoball"®

SELF-ALIGNING BEARINGS

ROD END TYPES

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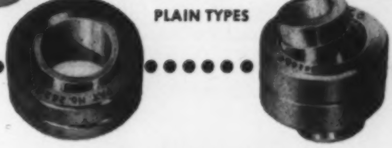
PLAIN TYPES



CHARACTERISTICS

	ANALYSIS	RECOMMENDED USE
1	Stainless Steel Ball and Race	For types operating under high temperature (800-1200 degrees F.).
2	Chrome Alloy Steel Ball and Race	For types operating under high radial ultimate loads (3000-893,000 lbs.).
3	Bronze Race and Chrome Steel Ball	For types operating under normal loads with minimum friction requirements.

Thousands in use. Backed by years of service life. Wide variety of Plain Types in bore sizes 3/16" to 6" Dia. Rod end types in similar size range with externally or internally threaded shanks. Our Engineers welcome an opportunity of studying individual requirements and prescribing a type or types which will serve under your demanding conditions. Southwest can design special types to fit individual specifications. As a result of thorough study of different operating conditions, various steel alloys have been used to meet specific needs. Write for Engineering Manual No. 551. Address Dept. MD-M59

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1705 SO. MOUNTAIN AVE., MONROVIA, CALIFORNIA

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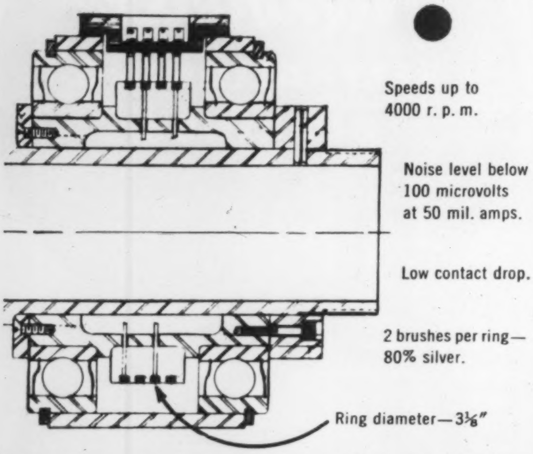
. . . meets the requirements for strain gages and thermocouple circuits


Speeds up to 4000 r. p. m.
Noise level below 100 microvolts at 50 mil. amps.
Low contact drop.
2 brushes per ring—80% silver.
Ring diameter—3⅛"

Superior service combines a trained engineering personnel with a pilot run department to develop slip ring assemblies which must satisfy rigid requirements. Noise, altitude, speeds, and other phases peculiar to customers' specifications present numerous problems which have been solved by the Superior technical staff. As an early entrant upon this exacting and fast expanding field of instrumentation, Superior confidently places a large fund of reliable findings at your command.

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SILVER BRUSH GRADES
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many standard sizes

Low noise level necessarily became an important phase in Superior's early work. Necessarily, Superior silver brushes early met the requirements of circuitry where noise and contact resistance were critical. Take advantage of Superior's extensive backlog of experience to design and manufacture your rotating current-transmitting products.

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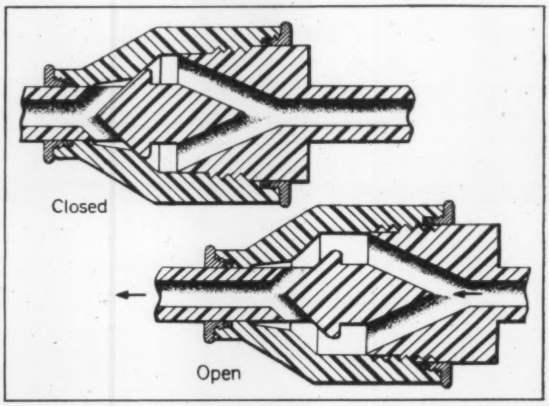
BRUSHES • CONTACTS • SLIP RING ASSEMBLIES
POWDER METAL PARTS • MECHANICAL CARBONS

guide rollers, which are not powered. To accommodate materials of different diameters, or to strengthen grip, the positions of the upper two rollers can be adjusted. Similarly, an adjustable roller controls tension in the lower chain. *Patent* 2,875,890 *assigned to Fred C. Good & Sons Inc., Cheltenham, Pa., by Fred C. Good.*

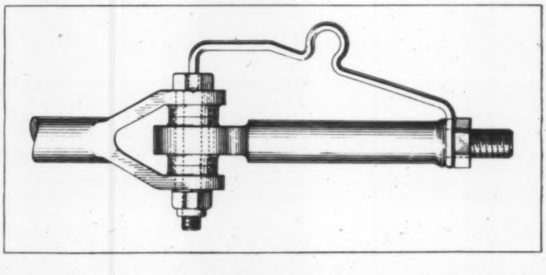
All Plastic Valve

Two molded plastic members, packings, and packing flanges comprise a valve to control flow of fluid, such as foods, which would be spoiled by contact with metal. Inlet passage, plug, and outlet passage are all one piece. An outer sleeve is threaded onto the largest OD of the plastic core member. Rotation of the sleeve in one direction opens the valve. Reverse rotation closes the valve. When the valve is closed, line pressure wedges the tapered plug firmly into the angular seat in the sleeve. *Patent* 2,865,596 *assigned to the Lunkenheimer Co., Cincinnati, by Anthony Bernard Monnig.*



Antibacklash Linkage Joint

Simultaneously, backlash and axial play in a linkage are minimized by a wire spring formed to engage a pin and a link connected to the pin. One component of spring force, parallel to the link, takes up backlash. Another component, through the pin axis, forces the pin in one direction axially against the members it joins. *Patent* 2,877,034 *assigned to Northrop Aircraft Inc., Hawthorne, Calif., by Ronald E. Crandall.*



Circle 600 on Page 19

TRU-SEAL
TEFLON SEAL
PAT. PENDING

Saves hours in piping installations

Eliminates leaks in oil, air, water, vacuum, chemical lines

Tru-Seal saves hours in assembling piping installations because it enables you to run your pipe lines in any direction you wish, quickly and easily—without having to recut and re-thread piping sections. Wherever used on air, oil, water, steam, vacuum or chemical lines, it seals perfectly at —100° F. to plus 500° F.—*without the use of pipe dope.* Its installation requires only light tightening torque, thus eliminating over-tightening damage to valves, pumps, compressors, and other fittings.

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2006 N. Hawthorne Melrose Park, Ill.
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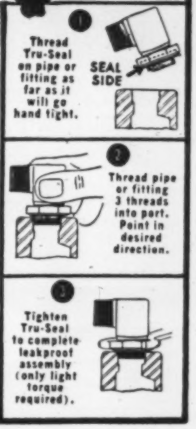
1
Thread Tru-Seal on pipe or fitting as far as it will go hand tight.
SEAL SIDE
2
Thread pipe or fitting 3 threads into port. Point in desired direction.
3
Tighten Tru-Seal to complete leakproof assembly (only light torque required).

Circle 601 on Page 19

SNAP RINGS FASTEN FOR KEEPS IN THIS NEW KIND OF AIR VALVE . . . ASSURE LONG TROUBLE-FREE OPERATION

In these 4-way valves there are no screws used to retain any of the valve parts. The valve body and solenoid cover utilize snap rings to complete an interlocking assembly *which can't work loose!* The MACsolenoid requires no fasteners whatever! Dual-Seal and companion line come in ¼" to 1¼" port sizes. Write for further information.

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Detroit 37, Michigan
Export Representative: Ad Auriema, 85 Broad St., NYC 4

MAC

Circle 602 on Page 19

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Yet, as a power source, it will be exactly what you want.

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COMMERCIAL MOTOR DIVISION
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Circle 603 on Page 19

THIS DRILL ELIMINATES SECONDARY OPERATIONS

Just *one* pass with these high-speed steel or carbide-tipped gun drills produces an accurate, truly round, straight hole honed to mirror-bright finish. That's why you can drill small parts of all kinds — *faster, more accurately* and at *lower cost* with HI-STANDARD Gun Drills*.

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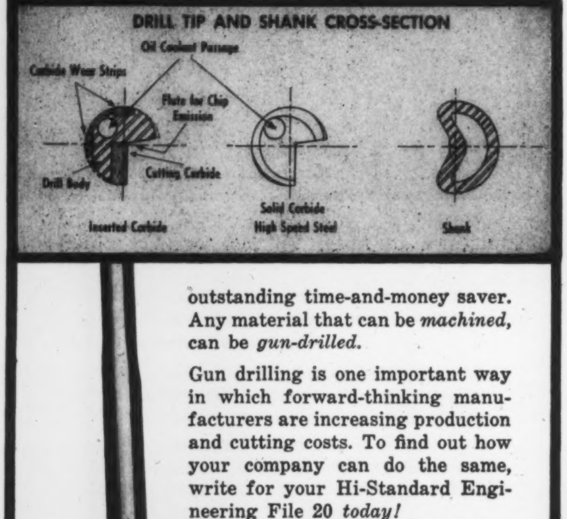

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HAMDEN • CONNECTICUT

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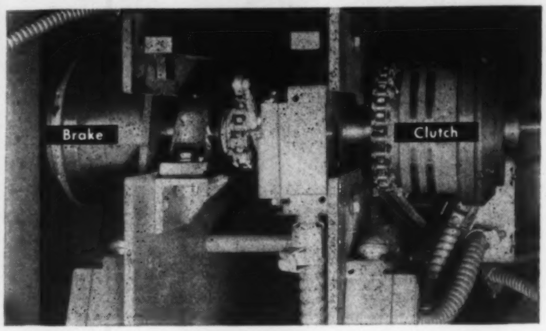

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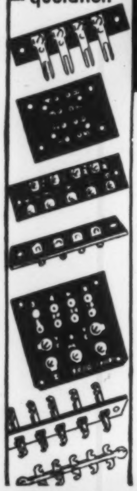

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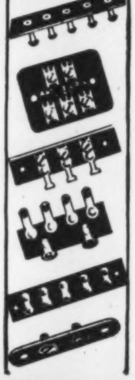

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Think of the maintenance money you'll save! *No* adjustment for wear is required on these new Dings "90M Series" magnetic Disc Brakes, even in the higher torque ratings. They *automatically* adjust for wear, practically eliminating maintenance until disc replacement is necessary.

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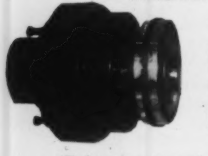

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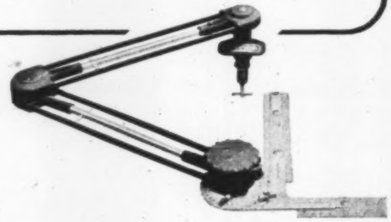

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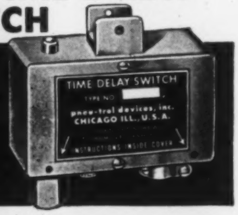
...Gives Cylinder Applications Greater Efficiency Accuracy ...Wider Use!



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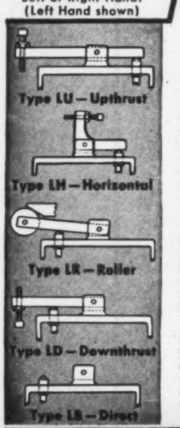

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- Automatically re-sets.
- Simple, Compact, Rugged.

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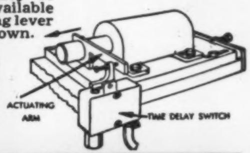

Switch mounted to provide dwell at end of power stroke of single action, spring return cylinder.

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A DIVISION OF AUTO-PONENTS, INC.
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Stearns MODEL "GS" electro-magnetic disc

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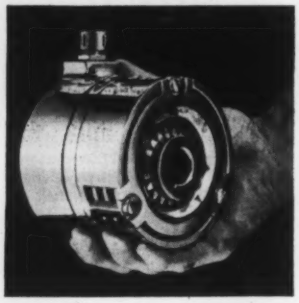

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WEIGHT—11 to 79 lb

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Tell when liquids are moving, if quality is right, and indicate flow.

Fig. 55A
Flow Sight

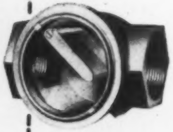

Fig. 811
Flow Indicator

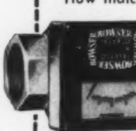

Fig. 816
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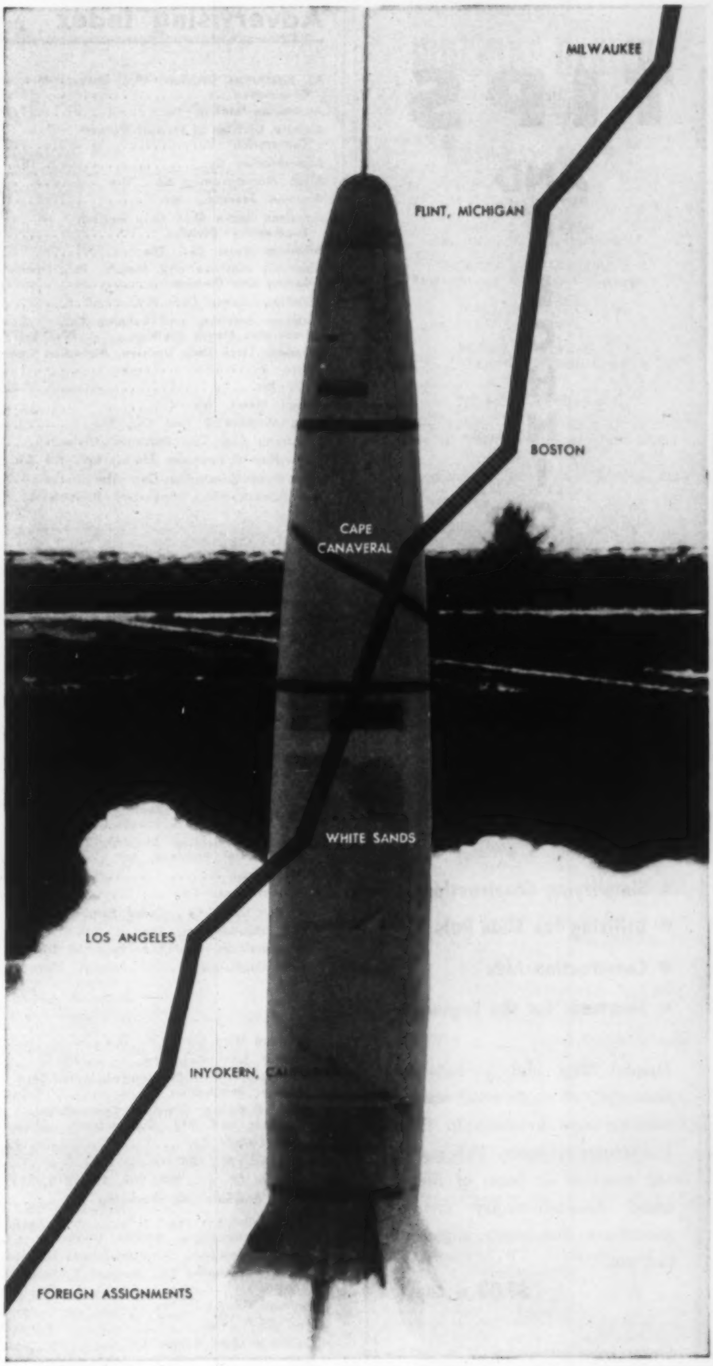

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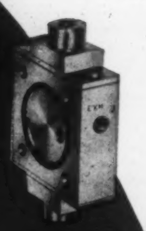

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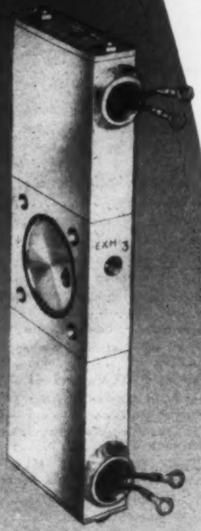

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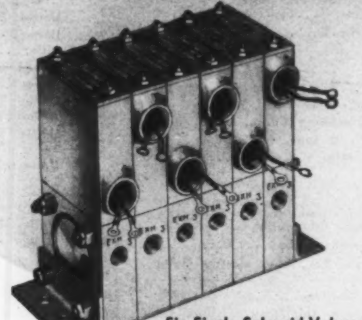

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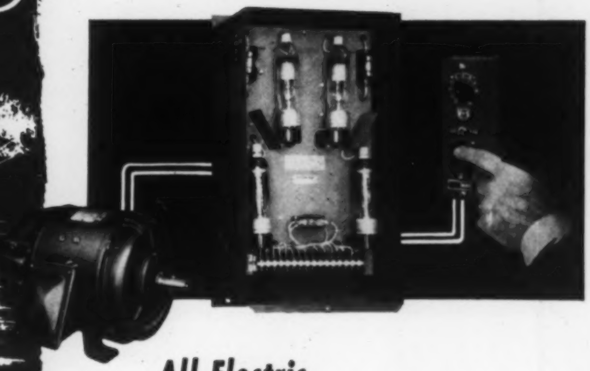

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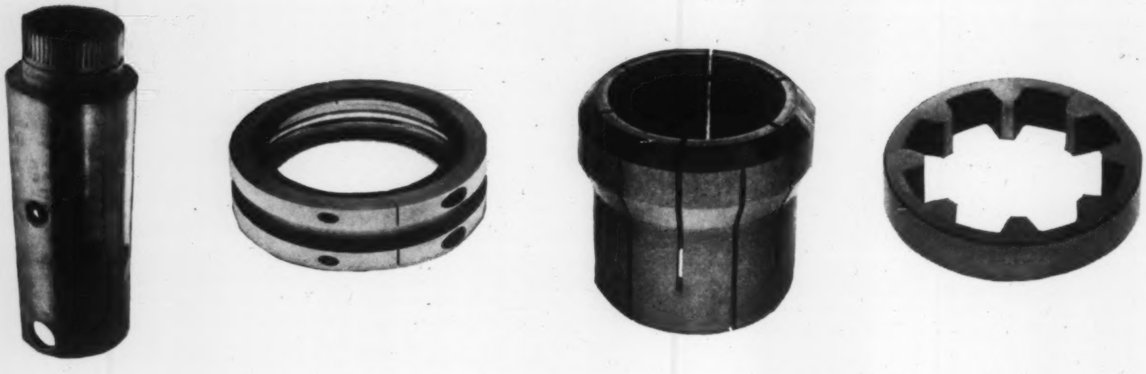

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